

Arc and Spark Spectra of Ruthenium

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The direct-current arc and high-voltage spark spectra of ruthenium have been investigated for the purpose of compiling a comprehensive line-list for forthcoming term analyses of these spectra. These spectra were observed photographically with 30,000, 15,000, and 7,500 lines-per-inch concave gratings in a Wadsworth mounting. Wavelengths and estimated relative intensities are presented for 6,000 lines in the spectra, Ru I, Ru II, and Ru III, in the wavelength range 2005.69 to 11483.91 Å. This list is compared with line lists reported by other investigators.

1. Introduction

Although ruthenium was discovered in 1844, and is a chemical homologue of iron, it has never been used extensively in industry or science. The limited uses of ruthenium are probably explained by the fact that the terrestrial abundance of ruthenium is only about one-hundred-millionth that of iron. However, because of certain important properties of noble metals considerable quantities of them have been refined and applied in arts and industries. In particular, ruthenium is used as a hardener for platinum and palladium jewelry. Complex alloys rich in ruthenium are also used for pen tips. During World War II the use of Pd-Ru-Pt alloy for aircraft sparkplug electrodes became extensive. Because this alloy insures engine operation with leaner fuel mixture, and consequent increase in efficiency, it is being used increasingly in automobiles.

The use of atomic emission spectra for the composition analysis and production control of complex alloys has become commonplace. For this purpose it is desirable to have fairly complete and reliable descriptions of the individual spectra so that interferences between spectra of different elements may be recognized. Such spectral descriptions are even more important for investigating the atomic and ionic properties, such as energy levels, electron configurations, electron-binding energies and the excitation potentials, of the radiations. In the course of compiling such data for volume III of "Atomic Energy Levels" [1],¹ it became apparent that additional information was needed for the quantum interpretation of Ru I and Ru II spectra. In preparation for such analyses, now under way, improved descriptions of ruthenium arc and spark spectra were made, and these are now presented in this paper. The necessity for doing this is best shown by reviewing the information previously available.

The first comprehensive compilation of ruthenium spectra was published in 1912 by Kayser [2]. That table of about 1,500 arc and spark lines includes the work of Rowland and Tatnall [3], of Kayser [4], of Eder and Valenta [5], and of Exner and Haschek [6, 7], but it omits nearly 500 faint lines reported by the last-mentioned observers. The wavelengths are all on Rowland's scale, and the range covered is 2107.43

to 7087.60 Å. Furthermore, only Exner and Haschek [6, 7] described both arc and spark spectra; the others observed only limited regions of the spectrum. All later wavelength measurements of ruthenium lines have been made relative to modern international standards. In 1914 Kail [8] reported 160 lines in the spark spectrum of ruthenium between 1875 and 2300 Å, and in 1925 Meggers [9] published 1,260 lines, with wavelengths between 5598 and 8690 Å, observed in the spectrum of a ruthenium arc. Underwater spark spectra of ruthenium were published in 1926 by Clark and Cohen [10] and by Meggers and Laporte [11].

The MIT Wavelength Tables [12], published in 1939, include 2,824 wavelengths ascribed to ruthenium. A more extensive list of wavelengths compiled from measurements of arc spectrograms at MIT was found in an unpublished thesis by McFee [13]; it contains wavelengths (2010.518 to 9392.83 Å) and estimated intensities (1 to 1,000) of 6,972 lines, but unfortunately there is no differentiation between the Ru I, Ru II, and molecular spectra.

The description of ruthenium arc and spark spectra presented in this paper consists of measured wavelengths and estimated relative intensities of 6,000 lines with wavelengths ranging from 2005.69 to 11483.91 Å. The estimated intensities for both spectra, ranging from 1 to 9,000 on comparable scales in the arc and spark spectrograms, indicate which lines belong to the first spectrum of ruthenium, Ru I, and which to the second spectrum, Ru II.

2. Experimental Procedure

Arc and spark exposures were made on three spectrographs, each having a concave Johns Hopkins grating of 22-foot radius in a Wadsworth mounting: (1) a 30,000 lines-per-inch grating used in the first order from 2000 to 2500 Å and from 4200 to 8876 Å, and in the second order from 2300 to 4400 Å; (2) a 15,000 lines-per-inch grating used in the first order from 6300 to 11325 Å; and (3) a 7,500 lines-per-inch grating used in the first order from 10838 to 11483 Å.

The spectra were photographed on Eastman SWR and 103-0-uv plates below 2300 Å, on E.K. 33 plates in the near ultraviolet, on E.K. 103 aF plates in the visible, on IN plates in the near infrared, and on hypersensitized IQ and IZ plates between 8000 and 12000 Å.

¹ Figures in brackets indicate the literature references at the end of this paper.

The purest obtainable ruthenium powder was pressed into ¼-inch electrodes in a Dietert hydraulic press. The principal impurities present were traces of palladium, rhodium, silicon, magnesium, copper, silver, platinum, osmium, nickel, sodium, lead, iridium, and calcium; a total of 63 impurity lines was found in the spectra. The electrodes were clamped in copper holders and were burned in a 220-v d-c 8-amp arc and a 30,000-v a-c condensed spark. All spectrograms were made adjacent to the spectrum of a d-c iron arc for wavelength calibration. Exposure times ranged from a few minutes in the near ultraviolet to several hours in the infrared.

The ruthenium lines were measured on a Gaertner comparator relative to the adjacent iron spectrum, which provided standards of wavelength. Each ruthenium line was measured on at least 2 and generally on 3 or 4 plates.

3. Results

The observed wavelengths are given in table 1, together with visual estimates of arc and spark intensities on a scale of 1 to 9,000. The conventional letter symbols are used to describe the character of the line: h=hazy, H=very hazy, r=reversed, R=strongly reversed, w=wide, W=very wide, c=complex, d=double, and B=band head.

In many parts of the spectrum, the longer exposures brought out an almost continuous background of weak lines of nearly uniform intensity. These lines appeared to be the components of many overlapping molecular bands. An attempt has been made to eliminate these lines from the list, but a few may remain and some real atomic lines of intensity 1 may have been mistaken for band lines and deleted.

A careful comparison has been made with the ruthenium lines printed in the MIT tables. Of the lines of intensity 25 or more in the present list, 384 were not listed in the MIT tables [12]. Of these, 274 have been confirmed by Exner and Haschek

[6, 7] and by Meggers [9], and the balance were of such an intensity that they would not have been observed by these authors. Of the lines listed in the MIT tables, but not confirmed by us or by the above authors, those at 7771.88, 7774.14, and 7775.41 Å properly belong to O I.

Large intensity discrepancies, too numerous to list, were found in many regions of the MIT tables. The most outstanding intensity discrepancies were noted in the line at 3417.332 Å, which is listed as intensity (1, 70) by MIT (20, 3) by Exner and Haschek and (1000R, 300) by us; and in the line at 3862.690 Å, listed as (2, 60) by MIT (8, 3) on Exner and Haschek, and (1,000, 200) by us. Our values and those of Exner and Haschek are in reasonable agreement if one corrects for the compression of their intensity scale.

4. References

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Table 1. Arc and spark spectra of ruthenium

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
2005.69		30	2069.79		6	2104.76		1	2134.34	7	
2006.45		15	2070.23		1	2105.53	2		2134.67		1
2009.28		100	2070.51		4	2107.30	50	200	2135.01		70
2010.54		1	2070.78		1	2107.78		1h	2135.405		30
2011.17		10	2070.98		3	2107.90	2		2135.51	2	
2011.60		5w	2071.43	4		2108.69		50	2137.83	1	
2013.18	2	2	2074.55	10	20	2108.99		2	2138.39		5
2013.63		1	2074.92		1	2109.593	5		2139.105		20
2013.95	1	1	2076.43	3		2109.91	1		2139.23		3
2015.17		2	2076.84		50	2110.726		20	2139.75		80
2018.55		1	2077.77	3		2110.993	1	1	2139.82		4
2021.84		2	2077.93	3		2111.18		2	2140.09	2	
2023.36		5	2078.45	5	20	2111.45		1	2140.11	10	15
2025.82		15	2079.98		5	2112.034		20	2140.29		1
2026.80	2	2	2080.12	1		2112.33	2		2140.88	15	
2029.03	1		2082.90		2	2113.23		3	2142.04		300
2031.17		2	2083.78	15		2113.87	25	50	2142.66	4	
2032.35		1	2084.13		4	2114.39		1	2143.72		1h
2033.77		1	2084.66		20	2115.21	1		2144.00	7	
2035.64		15	2084.76	20		2116.94	2		2144.30	6	
2035.85		2	2085.43	2		2117.170	25	50	2144.56		1h
2037.41		2	2086.06		2	2117.418	10		2145.15		1h
2038.38		2	2087.45	5	5	2117.745	2		2145.328	5	
2038.99		1	2087.91	1		2117.995		4	2145.74	5	1
2039.40		4	2088.39	5		2118.736		4	2146.600		200
2043.51		30	2088.85	2		2119.76		2	2147.70	3	
2044.01		20	2089.24	1		2119.79	2		2147.75		1
2044.59		100	2089.44		40	2119.87	2		2148.06		4h
2046.13		1	2089.92		1	2120.598		5	2148.11	4	4
2046.68		1	2090.22	6		2120.756		15	2149.59	6	
2046.83		1	2090.59	2		2121.780		10	2149.790		200
2047.58	3	3	2090.66		1	2122.51	1		2150.09	5	
2047.73		4	2090.81		1	2122.92		7w	2150.235		100
2049.12	20	40	2090.89	6		2123.607		2	2150.824	15	
2049.39	3		2091.97	1	4	2123.67	2		2152.105		1
2050.21		4	2093.60		25	2124.09		10	2152.411	15	3
2050.25	2		2094.33		3	2124.39	4		2152.605		25
2051.35		1	2094.40		2	2124.74	10		2153.41		1
2052.63		3	2095.72		5	2124.77		2	2154.41		3
2052.78		1	2095.83		15	2126.21		10	2154.448	20	1
2053.22	1		2097.24	8		2126.38		6h	2155.220		300
2057.07	1		2098.46	15		2127.18		200	2155.454		20
2057.55		3	2098.82	15		2127.400		70	2156.225		80
2059.26		5	2099.20		2	2128.825	10	25	2157.54	5	
2059.86	2		2100.15		1	2129.10	5		2157.70		5w
2060.04		60	2100.26		1	2129.42		2	2158.362	3	3
2060.24	1	1	2100.68	20		2129.84		2	2158.55	2	
2060.72		40	2100.75	2		2130.67	2		2159.78		2
2061.06	2		2101.25	2		2131.24		2	2160.212		150
2062.34		50	2101.69		1	2131.52		20	2160.394	10	
2062.77		1	2101.86		3	2131.90	10	30	2160.497		70
2065.11	30	50	2101.93	5		2133.12	4		2162.202	15	
2065.43		1	2102.76		2	2133.81		2	2162.855	2	
2066.66		30	2103.37		1	2133.97		5	2162.995		200
2067.32		1	2104.32	1		2134.17	1		2163.416	3	

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
2163.918	10		2195.15		20	2218.34		9	2246.21		2
2164.501	7	10	2195.27		20	2218.530	50	300	2246.91	1	
2164.690		2	2195.693		40	2218.88	3	15	2247.87		1
2165.325		15	2195.733	12		2218.89	15		2248.79		2
2166.231	10		2196.120	10		2219.11		9	2249.44	15	
2166.818		5	2196.901	20		2220.18	1	20	2251.63		200
2168.77		3h	2197.255		15	2220.48		3	2251.820	6	
2169.06		2h	2197.418		20	2221.26	4h		2252.20		7
2169.775	15	1	2198.033		30	2221.47		70	2252.35		60
2170.060	7	1	2198.833		2Hw	2221.770	1	20	2252.63		1
2170.126	7	1	2199.163	4	15	2222.770		15	2252.96		1
2171.098		1	2199.28		8	2223.570		3h	2253.65	50	1
2172.396	5		2199.459	6		2223.749	2		2254.45	20	100
2174.486	1		2199.53		10	2224.162	4	1	2254.71	30	
2174.69	8	40	2199.76		10	2225.22		1h	2254.953	4	
2174.811	10		2200.054		150	2227.13		15	2255.53	80	
2175.030		150	2200.280	15		2227.23		15	2255.56		80
2175.978	12		2201.303		30	2227.41		6	2256.07	30	100
2176.064		20	2201.72	3	15	2227.640	25	1	2256.187	40	
2176.452	10		2202.53		100	2227.69		2h	2256.25	2	20
2176.487		30	2203.37		120	2228.702	3		2256.67		50
2176.653		100	2203.67	8		2229.27	1		2256.88		70
2176.83		15	2203.83	4	8	2229.30	20	50	2257.115	2	80
2177.41		25	2204.045		15	2229.57		150	2257.40	1	
2177.43	12		2204.681		1	2229.76	1		2257.719	8	
2178.389	6		2205.101	5	20	2230.301	25		2258.149		30
2178.456		120	2206.61	1		2230.44		7	2259.529	100	2
2179.68		1	2206.716		20	2230.708	4		2260.03	20	60
2180.06	5		2207.31	20	60	2230.804	20		2260.160		60
2180.08		15	2209.05		30	2230.919		100	2261.019		90
2180.880		25	2209.08	40	2	2231.83		1	2261.56		15
2181.263	4	30	2209.213		10	2232.08	30	1	2261.780	7	100
2181.628	4	30	2209.356	1		2233.06		1	2262.11		10
2182.088	3	7	2210.655	4		2234.25		1	2262.702	70	1
2182.350	2	25	2210.98		1	2235.000	2		2263.079	3	
2183.687	20	1	2211.214	3		2235.836	25	1	2263.510	70	300
2183.829	10		2211.314	10	15	2236.261	4	1	2264.696	20	
2183.95		2	2211.67	1		2237.10		2	2265.39	1	
2184.53	3	3	2211.77		4	2237.50		50	2265.76	1	
2184.835	10		2212.22		4	2237.73		30	2266.41	1	
2185.94	1		2212.83	2	30	2238.20		60	2266.891	4	
2186.24	1		2213.16	3	40	2238.35	50	1	2267.379	2	
2187.632	2		2213.823	4		2238.700	2		2268.137	80	400
2188.650	5		2214.01		2	2239.080	1		2268.34	40	
2188.754	20	1	2214.337	8		2239.55		70	2269.543		40
2188.793		150	2214.383		2	2239.856	6		2270.322	20	
2189.082	2		2214.554		2	2240.13		1	2271.446	1	
2189.404		50	2215.501		50	2241.075	50		2271.583		30
2191.773		10	2216.64		20Hw	2241.278	2		2272.091	100	20
2191.922	10	20	2216.77	1		2243.23	60		2272.232		40
2192.41		10h	2216.946	3	15	2243.274		80	2272.692	2	
2192.86	50	200	2217.37	2	8	2244.04		2	2272.763		30H
2194.428	15	1	2217.46	3		2244.41		60	2273.193		2
2194.59		2	2217.76		8	2244.816		50	2273.655		3h
2194.96	10	25	2217.86	3	8	2245.87	3		2274.11		10

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
2274.79		15	2297.268		6	2317.25		3	2336.377		25
2274.995	50	150	2297.966	6	30	2317.784	80	40	2336.53	1	
2276.141	25	100	2298.11	8		2317.92	10		2336.83		200H w
2276.431	20	100	2298.21		5h	2318.464		50	2337.80	10	
2277.22		40	2298.45	2	40	2318.530	15		2337.84	20	100
2277.412		50	2298.632	30	90	2318.757	30	4	2337.98	6	
2278.198	50	2	2299.289	60	1	2318.905	40		2338.74		20
2278.24		5h	2299.641	40		2319.208	1		2339.098		20
2278.35		1	2300.350	50	5	2319.28		50h	2339.483	40	1
2278.68		50	2300.69		2	2319.665	3		2339.947	1	60
2278.842		10	2301.46		1	2319.776		150	2340.508	3	30
2279.252		15	2301.64		1	2320.23	40	1	2340.696	100	20
2279.584	150	20	2302.226	8		2320.36		20	2341.06	20	100
2280.31	1		2302.533	100	30	2320.699	60	1	2341.251	20	
2281.15	1	10	2302.812		150	2320.933	1		2342.02	40	
2281.61		40	2304.630	30	100	2321.235		8	2342.54		200
2281.717	80	300	2304.822	80	200	2321.657	30	80	2342.72	80	
2283.021		30	2305.517	70		2322.009	80	4	2342.848	100	300
2283.41		4	2305.606	60	200	2322.423	5		2343.434		30
2283.706		2	2305.734	3		2322.573		20	2344.08	20	1
2284.135		15h	2306.68		10H	2322.830	10	60	2344.459		20
2284.31		2h	2306.88		10H	2323.496		3	2344.534	8	
2284.49	6		2306.911	80	4	2323.661		3	2344.65	12	
2284.73		4h	2307.756		3	2323.76		40	2344.84		100H w
2285.10		7h	2307.938	1		2324.21		30	2345.480	1	12
2285.28		20	2308.178	3		2324.41	3		2346.340	40	150
2285.382	60	1	2308.28	4		2324.50	2		2347.07	1	
2285.78		4	2308.43		20	2324.57		2h	2347.42		20h
2286.200		2	2308.632	2	40	2325.406		6h	2347.712	1	
2286.39		1H	2309.145	30	70	2325.51		10H	2347.894		4h
2287.05	4	400	2309.382		10	2325.952	60	1	2348.318	100	2
2287.510	1	15	2309.524	5	50	2326.237	40	1	2348.740		3
2287.695	60		2310.03	15	2	2326.396	6		2349.338	150	20
2288.32		10	2310.602	1	3h	2327.536	15	4H	2350.075		5h
2288.478	1		2311.21		40H	2328.158	3	40	2350.14	60	1h
2288.55		10	2312.01		60H	2328.334	3	40	2350.531	30	200
2288.80	4	15	2312.35		5h	2329.015	50	150	2350.56	20	
2289.799		10	2312.74		10H	2329.30	2		2351.071		15
2289.98		10	2313.18		3	2330.140	10	30	2351.33	200	15
2290.52		5	2313.371	30	150	2331.06		300	2351.792		3
2291.167	50	3	2313.545	1		2331.43	60		2352.250		4
2291.819	20	50	2313.819		15	2331.70		40H w	2352.627		3
2291.907	30		2314.021	7	50	2331.770	40		2352.84	6	
2292.29		30	2314.779	7	50	2331.98	1		2352.94	15	
2292.333	40	1	2315.042		2	2332.31		50H w	2352.981		150
2293.044	30		2315.229	1		2333.30		20	2353.595	50	1
2294.054	50	1	2315.27	5	10	2333.566	30	150	2354.10	6	
2294.087		80	2315.569		7	2333.736	15		2354.24	2	40
2294.39		8h	2315.899	10	50	2333.89	70	200	2354.43		5h
2295.089		10	2316.125	2		2334.27	1	8	2354.67	2	
2295.560	40		2316.52		20w	2334.96	100	300	2355.633	5	25
2295.711		30	2316.61	2		2335.095	7		2355.968	4	20
2296.183	20	150	2316.706		4	2335.738	40		2356.466		6H w
2296.64		15	2316.884		5	2335.885	10	60	2357.072	6	
2296.878		10h	2317.07		5	2336.19	2		2357.916	200	600

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
2358.786	150	400	2380.85		3	2401.016	5	20	2420.826	200	1
2359.104	20	150	2381.147		3	2401.262		3	2421.278		3
2359.95	2		2381.99	150	400	2401.851	5	40	2421.580	1	
2360.093	90	3	2382.74	1	10	2402.715	200	800	2421.772	15	
2360.530	90	1	2383.415	30	90	2403.173	25		2422.08		5H
2360.61		40H	2383.96	10	5	2403.527	70		2422.165	5	
2360.712	50	1	2384.95		1	2403.798	3		2422.367		4
2361.91		5Hw	2385.29		2	2404.207	1		2422.574	50	1
2362.55		30h	2386.19	1	10h	2404.664		3	2422.683		3
2362.871	2		2386.678	6		2404.794	2	10	2422.767	2	
2363.022		6	2386.710		20H	2405.180	50		2422.844	3	40
2363.32		5H	2387.080	2	1	2405.280	5	10	2422.927	60	
2363.92		5H	2387.359	2		2405.65		2h	2423.089	4	
2364.227	5	50	2387.881	100	10	2406.059	5	20	2423.535	15	
2364.84	3		2388.043	1	10	2406.654		4	2423.62		5H
2365.14	1		2388.188	15	2	2407.311	3	20	2423.877	30	1
2365.353	8	1	2388.226		40	2407.45	1		2424.564	5	70
2366.01		3h	2388.53		3h	2407.66	10		2424.664	2	
2366.743	25	1	2388.67		2h	2407.915	100	300	2425.299	5	
2367.06	10		2389.255	2		2408.290	60		2425.46		3H
2367.224	30	150	2389.47		2	2408.44	2	50	2425.85		3H
2367.769	10		2389.688	20		2408.664	25		2426.118	2	
2367.88	3	15	2389.80		2	2408.990	3		2426.588	3	50
2368.37		5H	2390.112	20	15	2409.34		2	2426.699	10	
2369.65		20	2390.321		20	2409.68		25	2426.92	15	
2369.83	2	10	2390.423	1		2409.95	50		2426.989		40
2370.03	2		2391.095	1	20	2410.15	15	150	2427.24		2
2370.12	15	100	2391.443	1	30	2410.36	15		2427.752	10	60
2370.169	80		2391.766	4	60	2410.88	70	5	2427.753	10	60
2371.012	10	1	2392.425	150	20	2411.51	7	100	2427.878	1	
2371.84	10	80	2392.591		3	2411.76	10		2428.14		1
2371.914	10	100	2392.963	60	1	2412.31	3h		2428.313	10	
2372.13	3		2393.249	90	2	2412.64	1		2428.323	10	
2372.71		2H	2393.844	20	200	2413.395		40	2428.708	6	
2373.053		4H	2394.631		70	2413.80		20H	2428.865	1	10
2373.963	2	20	2394.77	1		2413.922	2	20	2429.009		10
2374.42	2		2395.011		3h	2414.212	2		2429.594	80	1
2374.67		7	2395.62	10		2414.819	60	150	2430.215	20	
2374.777		8	2395.721	80	3	2415.005	20		2430.398	4	60
2375.03		5	2396.16	2		2415.20	20	120	2430.62	5	
2375.272	100	8	2396.32	3		2415.719	20	100	2430.72		3h
2375.628	150	400	2396.55	2		2416.060		2	2430.94	5	50
2376.23	2	30	2396.710	200	600	2416.247	4		2431.07	1	
2376.35		5	2396.902	3		2416.443	4		2431.21		2h
2377.15		2h	2396.97	20	80	2416.59		40	2431.51	40	2
2377.23	1	2h	2397.406	20		2416.754	5		2431.82		2
2377.46		1	2397.49	3	40	2416.96	20	120	2431.98	30	1
2378.27		10h	2397.692	50	100	2417.624	8		2432.161	3	40
2378.75	2		2398.28	2		2417.815	3		2432.23	15	
2378.84		4h	2398.38	20		2418.065	4		2432.915	90	1
2379.07		2	2398.59		50	2418.607	2		2433.064	20	
2379.600	30	100	2399.52		5	2418.956	5	60	2433.477	25	
2379.84	50	100	2399.750	80	1	2419.205	30		2433.584	1	40
2380.39		1	2400.10	8	5	2420.105	1	15	2433.865		30
2380.553		7	2400.44		3H	2420.245		10	2434.03		2

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
2434.167	20	2	2449.86	70		2466.114	1		2482.538	10	
2434.51	5		2450.359	30		2466.388	4		2482.782	3	60
2434.745		6	2450.560	100	1	2466.608		1	2483.200		1
2434.879	40		2450.880		30	2467.049		1	2483.286	10	
2434.976	5	80	2451.23	5	40	2467.33		30	2483.37	10	
2435.132	1		2451.35	2h		2467.576	40	1	2483.537		3
2435.33		4	2451.66		10Hw	2468.29	3		2483.956		50
2435.508	30	200	2452.06	2		2468.60	2		2483.978	20	
2436.23		2	2452.53		5H	2468.71		2H	2484.492	2	5
2436.546	3	5	2453.816	7	60	2469.20	2		2484.670	2	10
2436.913	40	4	2453.928	5		2469.25		20	2486.469	1	
2437.078	2		2454.16	4	10	2469.771	10	40	2486.58	3	
2437.790	50	1	2454.555	8		2470.509	30	60	2486.70	3	
2438.055	6		2454.926	150		2470.71	30		2487.046	1	
2438.73	60		2454.991		10	2471.051		30	2487.201	3	8
2438.937		1h	2455.268	1		2471.48	50		2487.390	10	
2439.149		2h	2455.535	200	600	2471.76		3H	2487.512		4H
2439.408	1		2456.279	30		2472.09	40		2487.904	1	3
2439.63	50	10	2456.442	200	500	2472.437	1	20	2488.14	5	2
2439.694	20	150	2456.572	200	500	2472.604	1		2488.570	10	30
2440.05	20		2456.946	10		2472.732	2		2488.84	2	
2440.13		2	2457.175	5		2472.833	5	30	2488.882		3
2440.668	1		2457.19		20	2472.99	2	8	2489.339	10	50
2440.803	4	80	2457.34	2		2473.574		10	2489.77	30	
2440.977	20		2457.71	1		2473.686	1		2489.92	70	1
2441.200	7		2457.98	1		2473.83		5h	2490.441	20	
2441.322	10		2458.33	1		2474.029	80	3	2490.541		6
2441.366		70	2458.622	100	2	2474.396	15		2490.62	1	
2441.613		30	2459.041	8		2474.762	1	30	2490.793	2	
2441.761	2		2459.166	1		2474.846	30		2491.077		50
2442.934	50		2459.236		10	2475.395	200	3h	2491.100	10	40
2443.30		100Hw	2459.424		20	2476.148		4	2491.337	2	5
2443.46	1		2459.56	2H		2476.32	50		2491.559	3	40
2443.86	1		2460.178	3	20	2476.869	100	3	2491.76	60	
2444.032	50	3	2460.427	3	20	2477.008	10		2493.685	100	300
2444.189	1		2460.59	3	20	2477.17		10	2494.022	80	
2444.38	60	1	2460.73	30		2477.258		50	2494.157	2	10
2444.828	30		2460.996	1		2477.53	1		2494.48	30	40
2445.43	50	2	2461.44	1		2477.910	1		2494.893	1	
2445.55	20	40H	2461.535		5	2477.979		8	2495.353		2h
2445.94	3		2462.04	8		2478.355		20	2495.691	150	200
2446.154	3		2462.169	3	20	2478.399	30		2495.94		2h
2446.55		8	2462.652	5	25	2478.926	200	500	2496.56	50	1
2446.600	2		2462.943	100	1	2479.353	20		2496.859	1	25
2446.774		8	2463.786	3		2479.551	20		2497.359		1
2446.80	3	4	2463.86		1	2480.205		5	2497.680	40	1
2447.25	2		2463.98	1		2480.298	15		2497.866	30	1
2447.439	40	1	2464.245		2	2480.815	5	30	2498.41	100	200
2447.566	10		2464.366	20		2481.108	20	200	2498.577	100	200
2448.153	2		2464.699	100		2481.56	2		2499.384		8
2448.357		5	2464.755		100	2481.68	3		2499.550	2	
2448.512	2		2465.004	2	25	2481.85		15	2499.565		3
2448.865	10		2465.15	1		2481.981	2		2499.784	70	5
2448.91		10	2465.52		1	2482.077	10		2500.145		50
2449.58		200H	2465.749	2		2482.168	15		2500.38	10	

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
2500.518	8		2518.51	30		2535.227		50	2552.94	1	
2500.835	30	1	2519.20	30	75	2535.595	100	100	2553.288	1	
2501.48	70	2	2519.94	50		2535.966	20		2553.488		8
2501.885	60		2520.571		10	2536.20	20		2553.971	20	
2501.950	20	100	2520.787	4		2536.298		5	2554.29		1h
2502.295	1	40h	2520.825		40	2536.679		3	2554.398	1	
2502.37	25		2521.61	80	1	2537.34		10Hw	2554.685	8	
2502.87	15		2522.265		3	2537.697	5		2554.82		1h
2503.22		5H	2522.318	10		2537.88	10		2554.90	1	
2504.40	20		2522.59		25	2538.42	6		2555.655	5	
2504.51	20		2522.74		1	2539.09	25		2555.696		5
2504.917		10	2522.83	1		2539.71	5	100	2555.868	40	
2505.083	1		2523.09	10		2540.29	8	100	2555.927		30
2505.64		10	2523.16		8	2540.68	3		2556.004	40	
2505.89		15	2523.72		1	2540.84		1	2556.076		30
2506.25		25	2524.386		20	2541.28	70		2556.316	50	
2506.42		25	2524.85	10	100	2541.796		1	2556.722	1	15
2507.00	100	300	2525.17	30		2542.039		25	2556.948	4	
2507.50		4	2525.42		200H	2542.23		20	2557.126	1	
2508.270	100		2525.63	50		2542.92	1		2557.154		15
2508.38	30		2525.92	3		2543.16	10		2557.701	10	
2508.670		100	2526.82	200		2543.23	75	200	2557.998	1	
2509.066	50		2526.885		25	2543.47	1	100	2558.02		3
2509.421		3	2527.07		20	2543.67	50	1	2558.20	1	
2509.59	15		2527.30		3	2544.18		2h	2558.348	1	
2509.85	1		2527.347	3		2544.22	300	10h	2558.540	100	
2510.13	30	1	2527.60	10		2545.29		1h	2558.72	1	
2510.504	1		2527.732	4		2545.48	1		2559.406	5	
2510.965	50		2527.864		200	2545.76	30		2559.557		15
2511.22		6H	2527.94	50		2545.81		3Hw	2559.767	1	
2511.55	60		2528.05		100	2546.14	15		2559.959		3
2511.594		1	2528.71	50		2546.285	2		2560.265	125	1
2511.98	20		2528.874	75	1	2546.40		2H	2560.845	125	
2512.47	1		2529.456	7		2546.668	1501	10h	2561.22		1
2512.52		5H	2529.606		20	2547.080	2		2561.327	1	
2512.81	100	2H	2529.69	25		2547.48	20		2561.45	1	1
2513.17	10		2530.038		10	2547.66	1	20	2561.803	10	
2513.319	50	150	2530.41		70	2547.95		8	2562.168	1	
2513.608		1	2530.44	2		2548.16	3		2562.55	3	
2513.98	3		2530.64	75		2548.31		2	2562.820	1	
2514.16		3h	2531.52	3		2548.465	1		2562.937		2
2514.45	30		2531.68		2	2548.78		3	2563.157	50	
2514.88	10		2532.01	8		2548.856	4		2563.284		1
2515.27	80		2532.36	1		2549.16	5	100	2563.609		1
2515.63		8	2533.03		10	2549.470	300		2563.91		8
2515.75	1		2533.23	100		2549.56	300		2564.39	10	
2515.98	20		2533.389		6	2549.82		80	2564.41	10	
2516.08	25		2533.65	1		2549.965	30		2564.587	20	
2516.34	1		2533.94	5		2550.830	4		2564.832		1
2516.712		10	2533.97		100	2551.375	5		2565.188	20	
2516.73	10		2534.03	5		2551.565		5	2565.687	1	40
2517.32	100	200	2534.605	7		2551.72	60		2565.804	10	
2517.62	80		2534.780	2		2551.98	1	150	2565.943		5
2517.95	1		2534.921	2	80	2552.295	25		2566.248	1	40
2518.41		100	2535.03	10		2552.423	20		2566.590	30	20

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
2567.893	40	1	2582.785	3		2600.524	1		2617.181	3	
2568.772	75		2582.895	1	10	2600.719	5		2617.451	1	10
2568.876		100	2583.033	70		2601.284	3h		2617.677	20	1
2569.249	1		2583.070		20	2601.456	100	1	2617.790	70	2
2569.413		1	2584.136	100		2601.752	2		2618.594		1h
2569.575		8	2584.265	5h		2602.263		30	2618.737	20	
2569.729	50		2584.590	1		2602.884		5	2619.014	70	1
2570.093	30		2584.725	2		2602.977	2		2619.35	1	50
2570.973	100		2585.340	25		2603.218	2		2619.666	50	1
2571.094		150	2585.642	3		2603.249		1	2620.062	5	5
2571.44		1	2585.739	30	1	2603.800	25		2620.607	80	10
2571.732		1h	2585.901	10		2603.966	1		2620.690		20
2572.282	100		2586.087	10	1	2604.095	1		2620.870	15	
2572.412	100		2586.321	5		2604.131		10	2620.974	10	
2572.667		10	2586.83		10H	2604.315	30		2621.071	15	
2572.835	1		2587.235	1		2604.560	1		2621.277		20
2573.11		3H w	2587.452	3		2605.347	100	1	2621.738		3
2573.186	1		2587.871		75	2605.853	100	1	2621.854		2
2573.440		50	2588.193	5		2606.21		10H w	2622.191	1	
2573.543	3h		2588.677		1	2606.42	1		2622.26	1	3H w
2573.751	1		2588.82	1		2606.912		5	2623.431	3H w	10H w
2574.063		25	2588.876		2	2606.935	2		2623.611	1	
2574.276	1		2589.038	50		2607.249	3		2623.824	75	
2574.530		5	2589.43		100w	2607.348	50	1	2624.17		40
2574.809	1		2589.569	150		2607.49		1	2624.51	2	
2574.874	1		2589.785	30	5	2607.789	1	5	2624.711		5
2575.242	30		2590.963	10		2607.915	2	20	2625.081	5	
2575.58		1h	2591.037		75	2608.739	1		2625.392		25
2575.934		2	2591.116	100		2609.062	125	2	2625.576		10
2576.029	3		2591.26		75	2609.305		1	2626.205	30	
2576.091		50	2591.637	40		2609.476	75	2	2626.356	20	
2576.954	20		2592.022	100	2	2609.873	20		2626.413		30
2576.987		10	2592.617	1		2610.044	1		2626.478	50	
2577.273	1		2593.147		1	2610.090		25	2627.314	1	15
2577.314		5	2593.619	10		2611.045	80	1	2627.650	100	1
2577.518	2		2593.700	50	1	2611.502		40	2627.819	1	5
2578.111		2	2594.411		50H	2611.592	8		2628.15		5H w
2578.169	1		2594.855	100	2	2611.703	10		2628.262	25	
2578.571	100	10	2595.419	5		2611.822	5		2628.536	25	
2578.948	20		2595.539		4	2611.841		3	2628.708	1	
2579.022	40		2595.640	20		2612.06	150	1	2628.751		75
2579.097		60	2595.813		50	2612.52		40	2629.096	1	
2579.222	70		2595.930	10		2612.895	20		2629.37	1	5
2579.536	100		2596.807		1	2613.198	5		2629.552	3h	
2579.777	10	2h	2597.142		10	2613.31		5H	2629.925	40	
2580.026	10		2597.322	75		2613.797	50	1	2630.041		150
2580.218	3	5	2597.517	25	5	2614.055	100	1	2630.231	160	
2580.454		5	2597.656	1		2614.585	75	1	2630.980	1	
2580.590	1		2597.788	1	5	2614.862	2	50	2631.094	2	20
2580.803	100	2	2598.361	25	1	2615.05		75	2631.304	100	
2581.140	125	1	2598.574	20		2615.093	75		2631.569	100	
2581.434		5	2598.75	1		2615.401	1		2632.127	75	1
2581.911	50		2598.804		15	2615.43		1	2632.496	75	1
2582.540		3	2599.650	40		2616.331		25	2632.731		25
2582.597	1		2599.684		15	2617.076		40	2633.446	80	

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
2633.499		5	2652.139	5	1	2667.484	10		2686.291	175	1
2633.769	1		2652.944		10	2667.79	1	10	2686.418		3
2633.815		20	2653.098		8	2667.969	50	1	2686.889		15
2635.214		10	2653.150	15		2668.342	40	1	2687.071	2	25
2635.344	5	10	2653.693	25	1	2668.632		5	2687.138	40	
2635.841	100	70	2653.95		25	2669.060	3h		2687.494	30	100
2635.861	20		2654.327	25		2669.43		75	2687.592	5	
2636.537	10	100	2654.470	5		2670.48	2		2687.755	1	
2636.663	75		2654.524		1h	2670.527		15	2688.113	3	
2636.838		20	2654.804	20		2670.708	2		2688.147	10	80
2636.952	3		2654.876		10	2672.212	1	25	2688.583	50	1
2637.128	1		2655.008		5	2672.354	3	25	2688.888	70	
2637.961	1		2655.109	15		2672.880		10	2689.431		1h
2638.349	1	10	2655.221	30		2673.004	3	30	2689.894	70	
2638.515	75	1	2655.405	1		2673.477	80	1	2690.208		10
2639.121	75	2	2655.548	1		2673.605	80	1	2690.382	40	1
2639.34		1	2656.235	50	300	2673.790		1h	2690.725	2	
2639.58	1	15	2656.563	75		2674.219		10	2690.810	25	
2639.866	10	1	2656.698	75		2674.471	3		2692.120	250	400
2640.031	2h		2656.83	7		2674.827	3		2692.251	50	
2640.324	60	8	2657.163	75		2675.197		10	2692.665	1	
2641.461	10		2657.198		25	2675.543		25	2692.716	1	1
2641.628		50	2657.326		10	2675.645	1h		2692.842	80	1
2641.970	20		2657.366	3		2675.936	1		2692.969	4	
2642.104		5	2657.792	1		2676.183	1h	100	2693.30	150	
2642.520	5		2658.244	1	15	2676.354	80		2693.628		20
2642.643	4		2658.391	80	1	2676.71	1		2693.653	30	
2642.801		20	2658.672		1	2676.775		4	2694.199		1
2642.88		30	2658.768	10		2676.969	20		2694.598		1
2642.946	200		2658.922		1	2677.315	25		2695.342	1h	
2643.136		20	2659.289	2		2677.881	5		2695.467	1h	
2643.404		3	2659.617	100	5	2678.054		3	2696.495		2
2643.511	5		2660.152		1	2678.175	10		2696.542	25	
2643.601		3	2660.563		1	2678.759	300	800	2697.088		25
2644.617	3	40	2660.601	15		2679.450		5	2697.510	50	
2645.974		75	2661.036	1		2679.553	5		2698.050	15	
2646.002	75		2661.169	25	200	2679.763	50		2698.167		10
2646.621	10		2661.47	1		2680.382	1		2698.268		20
2647.088	1		2661.610	150	300	2680.533	2		2698.41	1h	
2647.314	75	1	2661.82	20		2680.585		100	2698.767	1	3h
2647.927	10	1	2661.861	50		2681.068	1		2699.228		5
2648.451	50	1	2662.151	1		2681.276	1		2699.261	1	
2648.617	4		2662.183		15	2681.293		2	2699.712	10	
2648.780	40	100	2662.540	2		2681.417		1	2699.793	20	
2648.782	40	100	2662.880		25	2681.587	1		2699.882	40	1
2649.506	25	1	2663.754	1	10	2682.632		3	2700.163		50
2649.575	20	1	2664.268	1	1h	2682.754		5	2700.477	30	1
2649.992	10	2	2664.761	100	2	2682.894		3	2700.671	25	2h
2650.264		3	2665.154	1		2683.676	60	1	2700.999	1	25
2650.395	30	1	2665.376		2	2684.089	60	1	2701.337	70	5
2650.584	10		2665.466	3		2684.452	10		2701.997	5	
2651.289	40	1	2665.719	25	1	2684.613		15	2702.401	4	
2651.508	20	1	2666.17	5h		2685.152	10	15	2702.639		10
2651.839	30	1	2666.829	20	1	2685.581		2	2702.833	80	5
2651.874	25		2667.390	20	100	2685.893		2	2703.120	4	

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
2703.311	4		2722.635	50	1	2739.777	1		2756.411		15
2703.796	50	1	2722.693	50	2	2739.986	1h		2756.574	3h	
2704.192		15	2722.82	10		2740.217	50	1	2756.899		1h
2704.585		80	2723.126		20	2740.59	1h		2757.064	30	
2704.830		10	2723.607	1h		2741.178	3h	5h	2757.375	1h	
2704.971	5		2723.812		2	2741.684	1		2757.798	80	1
2705.323	10		2724.066	100	5	2741.966	5		2757.998	15	
2705.568		1	2724.630		2	2742.401	2	25	2758.238	2	
2706.209	1		2724.864	2	100	2742.691		1	2758.347		5
2706.464	1		2725.13	1		2743.513	2	25	2758.692		2
2706.936		1h	2725.465	125	300	2743.700	1	5	2759.159		10
2706.967	1		2725.909	2h		2743.934	80	60	2759.324	1	
2707.310		50	2726.022	1		2744.448	125	20	2759.682	100	3
2707.477	70		2726.360	2		2744.705	3h		2760.115		8
2707.555		2	2726.969	50	2	2745.074	75		2760.155	30	
2707.969	100	1	2727.03		20	2745.158		100	2760.745		20
2708.635	25	1	2727.505	1h		2745.241	50		2760.943	5	
2708.841	25	1	2727.953	2		2745.827	15		2761.473		3
2709.000		1	2728.168	1		2746.068	25	20	2762.071		40
2709.045	5		2728.691	2	2	2746.695	1	25	2762.304	100	2
2709.198	125	3	2728.836	80	2	2746.885	75		2763.133	60	3
2709.755	5		2729.129	2		2747.163	1		2763.413	200	10
2710.228	6	100	2729.39		2	2747.563		10	2763.76	1	
2710.732	10		2729.455	60	3	2747.682	10		2763.900	50	2
2711.313	2		2729.790	1		2747.963	40	50	2764.229	10	
2712.077	30		2729.998	10		2748.045	40		2764.714	70	1
2712.409	100	300	2730.325	80		2748.150	10	1	2765.134	1	20
2712.868	10		2730.413		5w	2749.014	10		2765.429	50	100
2713.071		40	2730.688		5	2749.100		5	2765.521	5	
2713.192	75		2730.932	100	3	2749.11	15		2765.853	1	
2713.585	2	40	2731.389		3	2749.230		15	2765.889		15
2713.728	50	1	2731.59	2		2749.314	2		2766.223	50	1
2714.717		1	2731.903	30	1	2749.64	5h	5h	2766.563		80
2714.998	1		2732.685		3	2749.824	3		2767.389	1	
2715.101	1	1	2733.086	10		2750.345	50		2767.516	50w	1
2715.233	40	1	2733.578	125	1	2750.864	2		2767.689	1	
2715.495	50h	1	2734.013	3		2751.04	2		2767.938	1	
2715.773	75		2734.15	1		2751.618	5		2768.926	200	250
2716.132		30	2734.345	200	500	2752.110	4	10	2769.508	1h w	
2716.580	2	10	2734.666	1		2752.262	60		2769.893	1h	
2716.78	1	1	2735.669	250		2752.447	70	30	2770.088		1
2717.001	30		2735.727	250	50	2752.763	70	50	2770.296	50	4
2717.401	100		2736.315	10		2753.433	125		2770.698	100	1
2717.447		80	2736.456	1	40	2753.508		20	2771.060	1	50
2717.855	1	10	2736.826	15	60	2753.629	2h		2771.464	3H	5
2718.168	1h		2737.057	1		2753.761	1		2771.815	2h	
2718.828	50		2737.145	1		2753.831		2	2772.011		3
2719.51	250	5	2737.384		1	2753.968	10		2772.459	20	100
2719.717	25	20	2737.463	20		2754.358	10		2772.608	100	
2720.336		1	2737.606		10	2754.603	60	1	2772.956	60	8
2720.893	1		2737.783	2	20	2755.258		20	2773.559	1	
2721.033	1		2738.884	50	1	2755.519		4	2774.101	1h	
2721.562	70	3	2739.217	150	2	2755.748		1	2774.197		10
2722.081		1	2739.372		20	2755.98	1		2774.480	125	2
2722.386	15	1	2739.454	5		2756.181	1		2775.175	70	1

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
2775.540	2h		2792.32	50	100	2813.311	25	100	2832.224	1h	
2775.631	25	30	2792.641	75	1	2813.694	10	60	2832.624	40	
2775.902	80		2794.092	1	5	2814.104	1		2833.05	20	
2776.389	5		2794.278		20h	2814.247	1		2833.456	1	
2776.509	5		2794.678	20	1	2814.862	25		2833.806		50
2777.401		50	2794.845	5		2814.952		2	2833.999	80	4
2777.480	5		2795.349	8	10	2815.288	2		2834.232		2h
2777.54	5	50	2795.508	30		2815.523	1		2834.347	2	
2778.024		1	2795.555		8	2815.685		2	2834.579	1	
2778.04	1		2795.993		5	2816.116	1		2834.631	1	
2778.388	100	150	2796.049	1		2816.281		1	2834.792	10h	
2778.72	1		2796.461		8	2817.092	100	2	2835.415	2	
2778.975	5	30	2796.543	20		2817.255		1	2835.512	1	
2779.272	1		2796.697	40		2817.591		50	2835.840	1h	
2779.406	1	15	2796.904	1		2818.359	200	25	2836.143	50	1
2779.88	1h		2797.077		2H	2818.809	40	1	2836.319		2h
2780.759	70		2797.72	1		2818.950	75	5	2836.569	70	2
2780.817		8h	2797.747		10	2819.562	5		2837.112		3
2781.425	1h		2798.779		25	2820.521	1H		2837.269	20	
2781.616	1		2798.872	1		2820.667	1		2837.679	2	
2781.831	5		2799.426	1		2821.171	30		2837.814	3	
2782.205	80		2799.587		8	2821.34	1	100	2837.898	1h	3
2782.23		8	2799.927		15	2821.414	3		2838.438	1	
2782.361		10	2800.118	5		2821.689	1		2838.615	25	1
2782.557	1		2800.408		1	2821.883	1	1	2838.875		10h
2782.845	1	1	2800.586		2	2822.034	100	1	2839.205	5h	
2783.531	1		2800.676	3		2822.256	1		2839.385		10
2783.69	1	8	2800.796	3		2822.369	1		2839.677	1	
2783.799		4	2801.856	10		2822.542	40	150	2840.537	80	3
2784.320	3		2802.152	2	30	2822.778	5	10	2841.118	2	
2784.516	30	40	2802.717	2	3	2823.176	1	75	2841.147		50
2784.864	2		2802.805	125	2	2823.596	1	1	2841.173	2	
2785.186	1	10	2803.112		3	2823.878	2		2841.680	50	100
2785.334	75		2803.341	5		2824.122	2		2841.928	2h	
2785.649	80		2803.496	40		2824.756	10		2842.527	20	2
2785.741	2	75	2803.535		4	2824.959	1		2842.749	20	1
2785.87		25	2804.903		50	2825.071		30	2843.170	70	10
2786.383		15	2805.352	2		2825.162		10	2843.740	5	1
2786.710	5		2806.736	10		2825.484		40	2844.00	1H	
2787.25	1	20	2806.77		100	2826.230		50	2844.296	1	
2787.478	1		2807.200	1	25	2826.316	1		2844.395	1	
2787.823	100	200	2807.350		5	2826.674	5	50	2844.578	1	
2788.17	1		2807.554		20	2827.053	1h	2	2844.716	5	75
2788.388	5h		2808.221	50		2827.433		2	2845.229		15
2788.729		25	2810.029	150	5	2827.518	5		2845.537	25	1
2789.453		3	2810.249		8	2827.604		2	2845.976	1h	1
2789.615	2		2810.551	250		2827.857	100	10	2846.318	60	3
2789.833	1		2810.649		250	2829.092		20	2846.537	20	1
2790.082		5	2810.695	20		2829.149	200	20	2846.750	30	1
2790.240		15	2811.242	5	1	2830.578	2h		2847.087		10
2790.467	1		2811.545		10	2830.702	25	1	2847.574	1	20
2790.580	1		2811.735	3h		2831.523	20	1	2847.752	2	
2791.036	6		2811.931		10	2831.84	1	50	2848.586	80	5
2791.193		5	2812.689	1	1	2831.978	1		2848.812	3	
2791.927	3h		2812.817	100	1	2832.044	1		2849.289	20	50

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
2849.558	1		2865.544		10	2888.624	50	1	2911.788	1	
2849.591		15	2866.096	1	15	2889.047	1h		2912.167	2h	
2849.775	1		2866.276		15	2889.396		8	2912.185		1h
2850.024	1	2	2866.653	150	10	2889.420	2		2912.433	50	
2850.697		20	2867.107		10	2890.476		20Hw	2912.745	10	
2850.736	2h		2867.465	25	1	2890.879	10		2912.804		8h
2850.864	2		2868.183	25	1	2891.130	50		2913.163	60	2
2851.104	15		2868.310	30	2	2891.219		20	2913.462		1
2851.866	10		2868.412	8	1	2891.645	60	2	2913.749	1	
2852.461	1		2868.544	15	1	2891.987		2	2913.803		2
2852.993		5	2868.832	1	2	2892.470	10		2913.999		20
2853.126		10	2868.945	2		2892.556	50	5	2914.294	50	2
2853.321	15	10	2869.513	1		2893.731	20	1	2915.614	25	1
2854.075	200	25	2869.566	1		2894.148		1	2916.251	150	25
2854.343	2		2869.846	3		2895.802	15		2916.370	50	50
2854.528	1		2870.213	40	1	2896.523	100	4	2917.132	40	1
2854.722	3	40	2870.573		30	2897.180	10	1	2917.416		3
2854.870	3		2871.186	40		2897.713	20	40	2917.764	50	1
2854.980		15	2871.493		30	2898.242		40	2917.981	1	
2855.357		20	2871.642	100	5	2898.533	50	2	2918.521		50
2855.710		3h	2872.389	5		2898.715	3		2919.604	75	8
2855.891	30	2	2873.329		30	2899.502		10	2920.254	20	1
2856.044	30	2	2873.370	50		2899.716	50	1	2920.514		1h
2856.570		30	2873.752		15	2900.218	1		2920.765	1H	
2856.917	1		2874.050	25	1	2900.441		50	2920.949	30	10
2857.133	1h		2874.984	1000R	30	2900.669	1		2921.140	3	
2857.240	1	10	2875.316	10	1	2901.431		10	2921.406	3	
2857.313	2H		2877.092	40	1	2901.784	25		2921.494	2	
2857.590		2	2877.339	1		2901.937	50		2921.880		3
2857.646	10		2877.489	1		2902.026		75	2922.087	1h	
2857.780	3	50	2877.826	50	1	2902.087	50		2922.152	1h	
2858.042		1	2878.056		6	2902.572		2h	2922.192		1h
2858.506		3	2879.078	1	20	2902.854	25	1	2922.347		25
2858.533	1		2879.358	25		2903.074	40	1	2923.112		10
2858.591	2		2879.756	100	5	2903.394	1	3	2923.677	1	
2858.849	1		2880.091		4	2904.191	5		2923.711	1	
2859.622		10	2880.227	10		2904.704	10		2923.804	5	
2859.749		10	2880.440		5	2905.651	75	5	2923.906		40
2860.014	100	10	2880.506	2		2905.822	50	3	2924.648	20	
2860.369	20		2880.689	3		2906.315	60	5	2925.067	20	
2860.593	1		2881.038	2		2906.937		1	2925.748	2	
2861.108		8	2881.273	60	1	2907.160		1	2925.841	5	
2861.408	125	15	2881.777	5		2908.398	1		2926.519		3H
2861.686		5	2882.112	40	200	2908.481	2		2926.529	3h	
2861.718	40		2882.577	15	1	2908.883	150	8	2926.784	5	
2862.216	2h		2882.622	5		2909.212	30	1	2927.119	60	
2862.358	1		2883.594	75	5	2909.329		1	2927.535	60	200
2862.848	2h	10h	2884.500	50	5	2909.750		25	2928.063		2
2863.003	30		2884.843	80	1	2909.845		25	2928.487	50	
2863.261		50h	2885.473		3	2909.940	5		2929.122	1	
2863.324	20		2886.528	150	15	2910.425	20	1	2929.434	40	
2863.767	1		2887.084		4h	2910.772	10	1	2929.748	1	
2863.975	10		2887.118	25		2910.936	5		2929.919	30	
2864.274	1		2887.265	1		2911.014	2		2931.209		20
2864.618	1		2887.993	70	2	2911.148	2		2932.593	5H	1H

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
2933.059		3	2958.858	2		2982.026		10H	3008.797	75	2
2933.232	1	50	2959.229	1		2982.522	10		3009.537	1h	
2933.710		1	2959.729	100	1	2983.562	2		3009.687	20	1
2934.173	75	1	2960.216	1h	25	2983.781		1	3010.450		30
2934.498	1		2960.965	40	1	2984.365	1h		3010.501	40	
2934.658	2		2961.334	1		2984.744	2		3011.079	1	
2935.330	1		2961.538	1	20	2985.381	2h		3011.193	1	
2935.517		40	2961.685	75		2985.676		5h	3011.607	3	
2936.005	60	1	2962.08	1	10H	2985.812	20		3011.886	1	
2936.247	30	1	2962.191	1		2986.328	25		3012.915	75	2
2936.891	1		2962.544	1h		2987.269	2		3013.354	75	2
2937.043		25	2963.398	25	60	2987.694	30	1	3014.070	1	
2937.336	30	1	2963.714	100	1	2987.928	6		3014.208	1	
2937.543	1		2964.295	15		2988.089	10		3014.360		1h
2937.850	1		2965.168	150	2	2988.945	300	50	3015.008	1	
2938.967		1h	2965.554	75	200	2989.321	25	1	3015.410	1	30
2939.135	75	1	2965.694	15		2989.652	50	2	3015.956		5
2939.676	25	1	2965.879		5	2990.289	40	1	3016.684	2	
2939.938	80	2	2966.399		10	2991.453		10	3017.235	200	25
2940.352	100	2	2966.549	20		2991.621	50	70	3017.816	1	30
2941.212	1		2967.064	1		2991.966	1		3018.690		1h
2941.762	10		2967.342	50		2992.083		15	3018.750	1	
2941.979		5	2968.022		10	2992.120	40		3019.291	5	
2942.244	50	50	2968.398	30		2992.601		20h	3019.367	15	1
2942.699	1		2968.468	30	3	2992.948	30	1	3019.642		1
2943.470	60	1	2968.952	100	8	2993.142		10	3019.76	2h	5
2943.919	100	2	2969.739	2		2993.273	100	10	3020.218	1w	
2944.173	20		2969.854	2		2994.650		5h	3020.549	1	1
2944.380	10		2970.093	5		2994.967	150	10	3020.871	150	25
2945.098	1	10	2970.368	2h		2995.903	10		3021.23		1h
2945.661	100	500	2970.672		4h	2996.002		20h	3021.265	1	
2946.981	100	3	2971.057		2h	2996.331		1	3021.977		1h
2948.279		1h	2971.261	1		2996.449	5		3022.61		10h
2948.847	2	1	2971.757	25		2996.891	75	2	3022.946		10h
2949.492	150	15	2972.466	2	15	2997.421	50	1	3023.841		8
2949.947	2		2972.578	1	10	2997.613	50	1	3023.885	2	
2950.028		20	2972.98	1	8	2998.126		3h	3025.085	20	
2950.532	50	3	2973.602	1		2998.346	75	5	3025.398	1	
2951.401	60	2	2973.826	1	8h	2998.886	25	75	3025.836	20	
2952.246		10	2973.976	100	1	2999.789	1h	50	3026.457	1	
2952.489	80	1	2974.327	30	1	3000.217	60	1	3026.817		8h
2952.706		10	2974.643		4	3000.465		10	3027.076	60	1
2952.931	1		2974.882	1	4	3001.634	60	2	3027.535	1	
2953.003	10	1	2975.122	25		3002.050	5		3027.780	3	30
2953.932	1		2976.578	50	200	3003.473	20	1	3027.901	3	
2954.084		25	2976.923	100	10	3003.939	3		3028.271		1
2954.484	125	25	2977.219	30	30	3004.211	15	1	3028.423	1	
2954.855		1h	2977.471	5	25	3004.598	50	1	3028.554	1	
2955.348	50	1	2977.801	3	1	3005.141	1	25	3028.889	1	
2955.593	20	1	2978.361	30		3005.891		1	3028.928		5
2955.833	20	1	2978.638	40	50	3005.965	30	1	3029.373	5	
2956.062	5		2979.713	60	60	3006.588	300	10	3029.948	1	
2956.133	5		2979.946	70	70	3006.716		10	3030.406	2	
2957.166	4		2980.966		25	3007.88	2h	2h	3030.776	60	1
2957.996	100	6	2981.934	75	1	3008.262	75	1	3031.107	10	1

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
3031.899	50	1	3051.593	50	1	3073.548		40	3098.834	1	
3032.250		5	3051.854	1		3074.369	2		3099.284	250	30
3032.442		7	3052.075	1		3075.117	2		3099.908	2	3
3032.624		5	3052.334	15	1	3075.313	10		3100.582	10	1
3032.664	5		3053.124	5H		3075.33		20	3100.836	100	30
3033.076	3		3053.455	2h w		3076.773	60	3	3101.462		2h
3033.449	100	10	3053.80		1	3077.057	20	15	3102.136	10	
3033.911		8	3054.563	3	5H	3077.542	30	3	3102.364	10	
3034.058	50	5	3054.934	150	25	3078.066	1		3102.532		1h
3035.000	2		3055.294	1		3078.366	1		3103.333	3	
3035.471	50	3	3056.060	30	1	3078.453	2		3103.422		30
3035.792		15h	3056.108	30	1	3078.679	1		3103.748	2	
3036.463	40	75	3056.754	8		3078.919	1		3103.931	3	
3037.116		2h	3056.855	6	100	3079.120		4h	3104.457	50	1
3037.267	1		3057.353	50	1	3079.826	2		3104.607	4	1
3037.376	5		3057.974	1		3080.188	50	4	3105.278	50	20
3037.728	30	2	3058.650	75	2	3080.898	75	10	3105.407	50	1
3037.961	40	3	3058.795	75	2	3081.396		25h	3105.790	2	
3038.169	50	3	3059.101		20	3081.847		10	3106.837	50	5
3038.758		15	3059.175	75		3082.963		1	3107.586		30
3039.445	2h		3059.733	1		3083.145	60	2	3107.720	150	
3039.50		1h	3060.217	15	30	3084.521	30	2	3108.423	30	1
3039.674	10	1	3060.500		30	3084.877	4		3109.394	35	
3039.952	25	2	3061.764	5		3085.190	5		3110.536	75	5
3040.096		2	3062.043	25	2h	3085.473	5		3111.148		5h
3040.319	100	8	3062.07		8h	3086.076	75	10	3111.910	50	5
3040.922	1		3062.819		1	3086.520	20		3112.299	30	4
3041.906	40	1	3062.914	1		3086.624		25	3112.676	70	3
3042.367		1	3062.997	1		3086.771	10		3113.393	80	3
3042.480	100	10	3063.568	10h		3086.929	30		3113.947		10H
3042.829	60	8	3063.729	20		3087.924	1h	1h	3114.770	20	
3043.045	20	1	3063.915	1		3088.078	25	1	3115.436	8	
3043.342	1h	1h	3063.972	1		3088.245	1		3115.606		5h
3043.553	1h		3064.22	20w		3089.147	80	15	3116.657	50	
3043.936	1h		3064.366		1	3089.689		10	3116.834	25	
3044.00	1h		3064.834	250	50	3089.802	60	10	3117.060	4	
3044.314	1h		3065.708	5w		3090.225	50	10	3117.454	3	
3044.527	1h		3065.882	1		3090.523		5	3117.631	4	
3045.715	125	10	3065.968	2		3090.896	40	5	3118.065	80	50
3045.999	20	1	3066.102	1		3091.190	1		3118.687	80	5
3046.132		10	3066.34	20w		3091.361	2		3119.479	15	1
3046.243	50		3066.435		20	3091.867	70	10	3119.670	10	
3046.827		1h	3067.238	2		3092.245	2		3120.234		3
3046.989	3		3067.575		3	3093.456	2		3120.542	30	
3047.187	2		3067.665	5		3093.713	1h		3120.872		25
3047.223		1	3067.777	4		3093.902	1	100	3121.994	30	1
3047.702	2	25	3067.924	3h		3094.392	50	2	3122.310	3	
3048.30	1		3068.260	75	15	3094.565		25	3122.820	1	
3048.496	75	5	3068.610	4		3096.565	100	25	3122.954	1	
3048.793	150	10	3069.181	50	2	3097.225	40	2	3123.486	2	
3049.066	2		3070.116	1		3097.606	75	20	3123.892		10
3049.16	2		3070.317	1	4	3097.865	3		3124.164	100	5
3049.246	1	50	3071.484	30	1	3097.960	1	20	3124.362	25	2
3050.181	10		3072.341	4h	30	3098.116	2		3124.601	50	1
3050.334	1H		3073.337	80	5	3098.58	2		3124.678		25

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
3125.651	15	1	3148.493	75	1	3170.088	80	1	3197.482	5h	
3125.958	100	5	3148.716		2h	3171.239	50	1	3198.329	40	1
3126.342	2		3148.913		3h	3172.669	4	80	3198.624		20
3126.613	15	20	3149.901	1	1	3172.946		5	3199.119	15	
3127.258	2		3150.172	4		3173.110	25		3199.528	1	
3127.533	2		3150.699	100	40	3173.394	25	1	3199.821	1	
3127.923	1	25	3151.363	80	5	3174.128	60	1	3200.971	1	
3128.085	2		3151.686	2		3175.143	2	20	3201.260	30	50
3128.286	3	1	3152.311	3	2	3175.312	10	10	3201.512	70	5
3128.428	5		3152.611	1		3176.286	50	1	3201.812	3	
3128.920	1		3153.583	1h		3177.048	75	150	3202.598	40	1
3129.135	2		3153.831	150	20	3178.135	2		3203.555		10
3129.451	15	1	3154.428	25	1	3178.736	25	1	3204.071	75	3
3129.601	30	2	3154.639	1h		3179.025	2		3204.287		20
3129.835	75	5	3155.186	1		3179.24		10	3205.318	50	2
3131.845	1h		3155.895	3		3179.263	30		3205.567		2
3131.996	1w		3156.640	3	1	3180.455	10		3205.736	2	
3132.701		10	3156.821	25	2	3181.001	3	1	3206.491	2	
3132.874	100	5	3157.090	20	2	3181.189	5	1	3206.799	2	50
3133.511	4		3157.173		2	3181.985	1		3207.421		10
3133.687	20		3157.414	25	1	3182.144		1	3207.635	6	
3134.631	1		3157.626	20	1	3182.852	1		3207.841		15
3134.777	2		3157.850	15	1	3182.967	2		3208.293	25	
3134.817		25	3158.057	1		3183.137	1		3208.419	25	
3135.066	2		3158.899	125	8	3183.479		25	3208.732	6	
3135.199		10	3159.248	1h		3183.513	2		3208.813	8	
3135.807	1	25	3159.935	200	10	3184.177	1	1	3209.303	1	
3135.933	25		3160.631	1	75	3184.847	50	1	3209.422		3h
3136.349	5		3160.821	10h		3185.294		10	3209.489	3	
3136.554	100	5	3160.924	1		3185.447	10	1	3209.655	40	1
3136.911	30		3161.895	4		3186.042	200	25	3210.169	30	3
3138.022		1h	3162.078	1		3186.584	1		3210.688		2
3138.761	10		3162.223	3		3186.785	1h		3211.144	3	
3139.273	50	1	3162.589	1h		3187.822	1		3211.381		5h
3139.576		2h	3163.091	2		3187.939	40	1	3212.053	50	2
3140.086	10		3163.188	2	100	3188.340	200	25	3212.983	100	10
3140.485	75	2	3163.831	25		3188.609	25	5	3213.355	50	2
3140.979	125	4	3164.374	1		3188.916	30	3	3214.335	50	1
3141.594		10	3164.719		10	3189.297	30	2	3215.493	3	
3142.412	5		3164.834	5		3189.726	20	5	3215.910	50	1
3142.522	5		3164.950	5		3189.979	200	10	3216.528	100	10
3142.88	1		3165.071		50	3191.778	20	1	3217.523	5	
3143.240	1	40	3165.195	25		3192.068	100	5	3217.863		10
3143.650	5	60	3165.398	5h		3192.568		2h	3218.443	1	
3144.265	150	5	3165.887	1		3192.741	1h		3218.920	1	
3144.502	1		3166.091	2	15	3193.158	4H		3219.148	8	
3144.579	1		3166.339	2		3193.509	40	2	3219.418		50
3144.640	1		3166.542	1	15	3193.824	1		3220.081	50	2
3144.715	15		3167.381	5		3194.746	100	1	3221.187	50	2
3146.075	50		3167.458	1	75	3195.031	5		3221.360	3	25
3146.09		15	3167.820	8		3195.148	2	100	3221.946	1	
3146.395		3	3167.984	1		3195.317	15		3221.970	3	30
3147.214	100	1	3168.243	40	1	3195.746		5h	3223.279	200	15
3147.456	10	50h	3168.489	30	2	3195.909	1		3224.041		4
3148.021	10		3168.560	60	5	3196.606	200	10	3224.658	25	3

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
3224.938		15h w	3253.314		15	3277.976	3h		3305.653	1	
3225.320	2		3254.539	80	10	3279.391	30	2	3306.179	300	30
3226.380	100	15	3254.707	80	10	3280.297	2		3306.557	2h	
3226.526		3	3256.334	75	5	3280.462	100	5	3307.547	30	1
3226.906	80	2	3256.611	5		3281.193		2h	3307.985	75	5
3227.889	75	5	3257.102	4		3281.518		8h	3308.102		3
3228.158	40	3	3257.159		2h	3281.593	8		3308.624	50	1
3228.49		150	3257.748		20	3281.861	75	2	3308.885	1h	10h
3228.531	150		3258.042	75	8h	3282.605	10		3309.233		10h
3228.724	2		3258.774	15		3282.936	4		3309.650	3	
3229.768	50	2	3258.970	10	75	3282.973		60	3309.834	10	
3230.159	2H		3259.677	100	10	3283.574	40	1	3310.082	8	
3230.621	30	1	3260.147		10	3284.343	1	30	3310.283		15h
3231.485	2		3260.167	10		3284.935	150	15	3310.958	75	3
3231.586		10h	3260.367	400	15	3285.377	25	1	3311.225	10	
3231.782	1h		3260.838	1		3285.762		2h	3311.36	10h	
3232.753	80	3	3261.128	60	2	3285.915	25	1	3311.926	5	
3233.519	5		3261.747		2h	3286.114		1	3312.214	15	1
3233.680	2h		3263.131	5		3286.840		2h	3312.313	2	
3234.339	1	50	3263.856	100	5	3289.244	100h	3H	3312.831		10
3234.428	10		3264.561	100	5	3290.823	5		3313.010		1
3234.805	50		3264.663	100	5	3291.119	75	1	3313.623	4	
3235.098	10	2h	3264.795		25	3291.657	60	1	3313.738		1h
3235.786		5h	3264.977	5h		3292.260	75	1	3314.064	25	
3235.976	25	1	3265.649	2		3293.161	5		3314.512	2	
3238.537	100	30	3266.112		8	3294.109	500	15	3314.770	20	1
3238.780	30	1	3266.453	125	5	3294.232		300	3315.052	40	5
3239.596	30	3	3267.104	10		3294.755	5		3315.255	80	10
3239.686	10	1	3267.184		5h w	3296.116	100	15	3315.438	20	2
3239.928	1		3267.788	2		3296.645	80	10	3315.958	2	
3240.294	5h		3267.830	2		3297.259	80	10	3315.994	2	
3241.236	100	10	3268.214	200	30	3297.960	100	15	3316.106	2	
3241.786	1h		3268.803		60	3298.321		5	3316.380	150	25
3242.159	40	1	3268.935	25		3298.408	30	4	3316.908	20	
3242.850	25	1	3269.811	3		3298.454	30	4	3317.015		3h
3243.506	100	10	3270.155		3h	3299.336	100	5	3317.402		3
3243.998	3h		3270.244	25		3299.788	8		3317.591	2	5
3244.334	10	1	3271.452	2		3300.115		2H	3317.883	100	3
3244.456	15	1	3271.490	2		3300.64	10H		3318.821	40	2
3244.581	15	1	3272.010		1h	3301.14		15h	3318.900	40	2
3245.611	2	25	3272.243	5h		3301.170	3		3319.527	60	1
3246.222		25	3272.650	2		3301.219	3	15h	3319.801	25	1
3246.257	2		3272.695	2		3301.318	2		3319.903	2	
3247.36	20	1	3272.806	2		3301.593	500	50	3320.779	3	
3248.04		3	3273.082	200	25	3301.911	75	8	3321.248	60	1
3248.841	15	1	3273.612	3	10h	3302.182	5		3321.644	5h	
3249.924	25	4	3274.691	200	25	3303.264	3w		3322.223	25	1h
3250.002	50	4	3275.078	3h		3303.581	2w		3322.591	1	
3250.458	5		3275.729		15	3303.998	100	15	3322.784		3h
3251.327	50	2	3275.910	3		3304.288	1		3323.142	2	
3251.893	10	1	3276.344	1h		3304.502	40	2	3323.213	1	
3252.263	6		3276.677	3		3304.637	40	1	3323.501	1	
3252.540	10	1	3276.783		2h w	3304.789	50		3323.945	40	
3252.898	10	1	3277.341	40		3304.820	20	1	3324.553		2
3252.993	15	1	3277.564	125	20	3305.212	2w	1	3324.800		1h

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
3324.999	100	2	3353.310	60		3384.771	1		3420.090	300	8
3325.229	10		3353.648	100	2	3385.161	125	20	3422.414	8	
3325.286	10		3353.860	8		3385.403	2		3424.018		1
3325.407		25	3355.680	30h		3385.480	30	3	3424.131		1
3326.099	20		3356.201	50	5	3385.704	50	5	3424.381		5h
3327.700	100	1	3356.476	25	1	3386.254	50	2	3425.952	30	1
3328.456	25		3357.15	3		3387.232	50	2	3426.434	10	2
3329.404	3		3357.512	5		3387.963	1	3H	3427.728		6h
3329.811	2		3358.37	2		3388.710	200	16	3428.319	1500R	100
3330.270	3w		3358.663	5		3389.503	150	10	3428.628	80	10
3330.581	10		3358.707	5		3390.899	16	1	3429.547	200	30
3330.931	3		3358.818	3		3391.895	60	2	3430.387	2	
3331.14	10w		3359.095	200	25	3392.027	2		3430.764	500	60
3332.051	125	2	3359.230	15		3392.533	300	20	3432.204	150	10
3332.641	125	2	3359.324	15		3393.259	2		3432.755	400	50
3333.759	5		3359.507	1		3393.904		1	3433.10		1h
3334.963	2		3359.780	2		3395.305	1h		3433.255	600	20
3335.689	150	5	3359.985		5h	3395.920	2		3434.02		2h
3335.852		1	3360.060	3H		3396.826	10	1	3435.183	200	20
3336.22	4h		3360.327	2		3398.335	1		3436.330	20	5
3336.631	60	2	3360.79	1		3398.862		8h	3436.737	3000R	150
3337.829	60	2	3361.145	50	1	3399.383	50	2	3438.369	400	30
3338.329	2	1	3362.007	100	5	3399.983	4		3438.681	50	2
3338.713	40	3	3362.140		8	3400.594	4		3440.207	500	40
3339.555	500	50	3362.337	50	5h	3400.750	20		3443.153	40	1
3339.788	2	75	3364.100	60	8	3401.188		5h	3445.296	20	1
3340.404		1	3364.824	10	1	3401.508	20	2	3445.939	6	
3340.789		2h	3365.093	4		3401.740	500	50	3446.070	50	2
3340.943	2h		3365.384	1	2h	3403.779	6		3446.490	50	2
3341.090	60	1	3366.788	1h		3405.147	3		3446.750		10H
3341.34		1	3367.735	4		3405.280	5		3448.959	500	30
3341.665	150	30	3368.455	250	30	3405.885	50	5	3450.821	1	
3342.064	2		3368.863	2		3406.598	60	5	3451.224	1	
3342.665		2	3369.288	5	40h	3406.914	2		3452.906	400	10
3342.709	6		3369.674	50	1	3407.581	1h		3455.385	30	2
3342.90	6w		3370.061	2h	30h	3409.279	400	40	3455.737	20	2
3343.200		50	3370.16	2h		3409.573	20	1	3456.621	200	5
3343.431	1		3371.863	125	10	3410.03		1h	3457.688	2	
3344.266	1		3373.472		2h	3410.742		50h	3459.585	40	2
3344.535	75	8	3373.986	75	3	3411.637	300	10	3460.647	2	
3344.806	8	2	3374.656	125	10	3412.076	10	2	3460.742	2	
3345.316	75	8	3374.901	50	3	3412.799	100	4	3461.930	60	2
3346.24	3H		3375.258	30		3413.719	4	1	3462.04	3	
3347.374	1	1	3376.058	15		3413.983	4	1	3462.983		10H
3347.617	100	5	3376.624		2h	3414.133	1		3463.143	300	6
3348.017	50	2	3377.633	1		3414.278	6	1	3465.292	4	
3348.704	75	1	3378.034	125	10	3414.641	100	2	3465.405		10h
3349.674	5		3379.033	25	1	3414.843	6	1	3467.051	75	2
3350.109	50		3379.267	40	2	3416.188	80	2	3467.876	1	
3350.246	5	300	3379.608	100	15	3416.612		5h	3469.269		5h
3350.550	30		3380.173	100	10	3417.332	1000R	300	3469.907		1h
3351.695	2		3380.356		3h	3417.648	20	1	3470.001	2	
3351.930	100	4	3380.575	2		3417.975	50	2	3470.283	1	
3352.970	10	1	3380.916	50	1	3418.154	2		3470.661	5	
3353.29		8	3382.229	1	2	3419.248	50	1	3472.244	150	10

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
3472.669	20	2	3514.757	60	1	3547.380	50	2	3582.801	2	1
3472.739	10	1	3515.171	2		3547.760	10		3583.104	2	
3473.195		1h	3515.682	40	2	3548.220	1		3584.022		20h
3473.752	700	100	3515.897	40	2	3548.508	1	10H	3584.198	150	10
3474.845	100	2	3516.194	6		3549.632	6	1	3584.880	2	
3477.238	2		3517.417	20		3549.737	30	2	3585.150		6H
3477.830	2		3518.009	2		3550.271	200	10	3585.43		4H
3478.061	1		3518.991	60		3550.635	50	6	3585.812	30	
3478.915	2		3519.641	500	30	3551.220	10	2	3587.204	300	100
3479.339		5h	3520.063		20h	3553.672	20	1	3589.220	2000R	200
3479.794	2	1	3520.134	300	10	3553.850	200	50	3590.525	10	2
3480.060		2h	3521.972	40	1	3554.274	10		3590.884	60	6
3480.141	20	1	3522.284	40	1	3554.649	2		3591.333	2	
3481.308	600	80	3523.167	1		3555.827	2		3591.518		30h
3481.928		2h	3523.275	1		3556.168	5	1	3593.029	3000R	200
3482.347	80	2	3523.917		6	3556.393	6	1	3596.057	50	10
3483.174	200	10	3524.161	4		3556.634	125	6	3596.185	2000R	200
3483.294	200	10	3524.480		20H	3556.816		10H	3597.850	2h	
3483.649		5h	3524.655	2		3557.062	125	6	3598.225	10	
3486.211	50	1	3524.905	50	1	3559.643	4	2	3598.478	20	
3486.799	50	1	3525.657	10	1	3559.883	50	2	3599.400	30	6
3487.461	4		3525.829	10	1h	3560.029	20	1	3599.769	1000	150
3487.672		5h	3526.578	80	1	3560.175	30	1	3601.487	150	10
3489.750	15		3527.183		20H	3560.569	1		3601.613	1	2
3490.277		5h	3528.030	20		3561.570	40	1h	3601.955	2	
3490.729	20	2h	3528.679	250	50	3561.900	100	10h	3603.059		2H
3492.104	10		3529.292	50	5h	3562.618	60	4	3603.365	4	
3493.227	50	1	3529.621	2		3563.148	20	2	3605.640	200	20
3494.254	150	15	3531.389	200	30	3563.611	20	2	3606.153	20	1
3495.985	150	15	3531.808	10		3563.827	10		3606.546	4	
3496.130	100	2	3532.063	8		3564.133	10		3607.414	6	
3497.617	2	1	3532.810	300	50	3564.364	100	10	3608.729	150	20
3497.935	100	4	3533.917	25	1	3564.504	30	8	3609.102	60	2
3498.944	6000R	600	3534.414	1		3564.570	150	20	3612.332	2	
3500.528	2		3535.059	50	1	3564.809	60	10	3612.463	2	
3500.86		10h	3535.32	60	2	3565.248	2		3612.482		5H
3501.365	60		3535.382	200	10	3565.437		5H	3612.934	4	1
3502.039	2		3535.836	200	20	3566.452		10H	3613.854	15	1
3502.423	80	10h	3536.572	60	10	3566.736	1		3614.342	5	2
3504.56		2h	3537.941	400	50	3567.157	100	10	3615.206		2h
3505.712	2		3539.254	200	20	3567.751	10	1	3616.056	5	
3505.910	2		3539.368	400	50	3568.527	50	2	3616.954	150	15
3507.327	3h		3540.210	50	1	3570.606	1000	200	3618.570	2	1
3508.371	2		3540.673	2		3571.767	60	2	3619.201	200	30
3509.217	2	200	3541.040	50	1	3572.022	150	5	3620.288	150	15
3509.716	100	2	3541.622	200	20	3573.666	10		3621.573	2	
3510.314	4		3542.617		2H	3574.601	200	50	3621.985	2h	
3510.975	3		3542.909	4		3575.054	40	2	3623.634	60	
3511.131	20		3544.677	2		3576.871	50	4	3623.694	50	5
3511.40		2h	3545.176	1		3577.045		6h	3623.855	10h	2h
3511.561	10		3545.713	2		3577.540	70	4	3625.197	300	50
3512.885	40	1	3545.797	10		3578.686	30	2	3626.740	300	100h
3513.299	2		3546.014	4		3579.773	100	10	3627.285	100	10
3514.12	5		3546.982	100	4	3581.820	1		3627.896		2h
3514.491	1000	60	3547.184	50	2	3582.395		1	3628.629		4h

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
3631.414	20	1	3674.634	2		3714.644	50		3753.546	150	60
3631.710	150	20	3675.253	40	4h	3715.559	125	10	3755.094	200	20
3632.109	2		3675.603		2h	3716.173	150	15	3755.728	50	4
3632.412	20	2	3676.289		4h	3716.998	300	60	3755.937	300	80
3633.916	150	10	3676.376	2		3717.674	40	5h	3757.730		2h
3634.931	1000R	200	3676.663	60	10	3718.400	50	2	3759.838	200	50
3635.512	150	20	3676.952	40	4	3719.325	300	80	3760.019	400	60
3637.461	250	50	3677.976	10	1	3720.212	1		3761.511	200	60
3638.011	150	10	3678.056	10	2	3720.627		2h	3763.595	2	
3638.540	2		3678.314	200	16	3721.929	4		3764.037	50	6
3639.140	1		3680.052	10	2	3722.303	10	2	3765.808	10	2h
3640.638	150	10	3680.430	1		3722.645		5h	3766.478	6	2h
3644.275	5h		3681.658		2h	3724.967	150	10	3766.72		1h
3644.582	2		3681.986	1		3725.482	50	6	3767.353	150	80
3644.852	4		3682.402	1		3726.096	300	40	3769.012		10h
3645.201		2H	3682.644	1		3726.926	5000R	300	3769.243	2	
3645.674	40	1	3683.573	16	2	3728.026	9000R	300	3769.870	4H	
3646.111	150	10	3684.126	1		3730.432	2000R	150	3770.463	2	
3649.196	2		3685.050	40	4	3730.592	50	3	3771.076	2	
3649.538	2		3685.944	100	10	3730.899	40	2	3771.100	2	
3649.771		2H	3686.588	20	2	3732.020	100	6	3771.918	2	1
3650.324	175	10	3688.776	4		3732.744	4		3772.386	2	
3652.311	100	4	3690.030	30	150	3733.041	100	2	3773.175	60	6
3652.488	7	2	3690.706	1		3734.132	2		3773.808	6	
3652.614	2		3690.995		10H	3734.195	2		3774.474		10h
3652.667	2		3691.263	2h		3734.455	4	50	3777.588	400	50
3652.836		5H	3691.448	1		3734.834		4h	3777.758	60	4
3653.698	30	2	3692.358	30	1	3735.020	40	2	3777.923		6
3654.405	150	40	3693.589	50	4	3736.823	2		3778.711	150	20
3655.936	4		3693.634	10		3737.407	300	50	3779.426	10	2h
3655.984	6	1	3693.760	150	10	3737.758	50	4	3779.969	50	2
3656.563		2H	3693.996	4	2	3738.630	150	20	3781.171	150	30
3657.169	150	4	3696.583	200	30	3738.914	200	40	3781.660	30	2
3657.571	10	60	3697.857	60	4	3739.470	250	60	3782.272	2H	
3657.733	2		3698.874	1		3740.230		5H	3782.749	120	4
3659.470	30	1	3700.344	60	2	3740.468	2		3784.175	2H	10h
3660.070		30h	3700.980	150	20	3741.006	10		3784.190	5h	
3660.813	60	10	3701.312	60	2	3742.287	1000R	200	3784.749	6	
3661.364	2000R	400	3701.833	2	1	3742.798	400	200	3786.065	1000	300
3661.570	50	6	3702.228	50	2	3743.328	60	5	3790.521	1500R	400
3663.07	3	1	3702.920	6		3743.956	40	5	3793.916	2	
3663.378	800	150	3703.203	60	4	3744.219	125	30	3794.924	125	20
3665.868	2		3705.347	30	2	3744.396	125	50	3795.185	100	10
3666.550	1		3705.400	3		3745.592	500	300	3795.691		4
3666.831	6H	2H	3707.976		6H	3746.218	50	2	3798.054	250	30
3666.88		2h	3708.592	6h		3746.932		10h	3798.899	3000R	150
3667.035	4		3709.089	4		3747.453	2	5h	3799.353	3000R	150
3667.982	2		3709.21		10H	3748.134	2		3800.261	150	30
3668.742	30	2	3710.151	2		3748.411	2		3801.843	2	
3669.546	600	100	3710.302	20	2h	3749.334	6		3802.660	2h	
3671.212	80	4	3710.998		2h	3749.799	6h		3802.724	2h	
3672.059	10	2	3712.299	100	8	3750.289	2h		3803.191	100	16
3672.378	100	4	3713.191	2		3750.508		8	3804.056	1	
3673.209	2		3713.432		2H	3751.856	40	6	3804.572	1	10
3674.002	2		3714.082	2		3752.787	60	2	3805.432	100	12

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
3805.685	6	2	3853.692	2		3903.223	2		3957.448	100	4
3806.567		5h	3854.287	2		3904.152		3h	3958.863	2	
3808.689	125	30	3854.720	100	6	3905.171	4		3959.208	2h	
3810.870	4h		3855.579	5	1h	3905.993	20	2h	3960.941	2	
3811.166		4h	3856.458	300	20	3907.651	1	4h	3964.908	500	60
3811.805		2h	3856.972	60	2	3908.768	125	20	3969.794	100	2
3812.739	300	60	3857.551	1000	200	3909.085	600	100	3970.404	4	
3813.164	10	2h	3857.998	30	2	3911.147	40	2	3974.504	150	6
3814.848	150	20	3858.687	60	4	3912.117	125	8	3976.729	2	
3816.207		2	3859.696	100	10	3912.992	2		3978.449	500	60
3817.293	200	100	3860.725	200	30	3913.761		3h	3979.420	500	50
3817.948	50	4	3861.453	30		3914.13		1	3981.895	60	2
3818.354	30	2	3862.690	1000	200	3914.32		1	3982.217	50	
3819.039	400	60	3863.975	2		3914.859	200	30	3984.678	20	5
3819.764	100	6	3864.851	40		3917.596	2		3984.862	1000	300
3820.386		5h	3865.419	150	10	3917.706	4		3987.797	400	100
3820.964	10h		3865.742	6		3919.557	6		3988.841	2	
3821.650	10	1	3867.186	4		3920.923	150	60	3989.194	60	2
3822.091	300	80	3867.844	1500	100	3922.01	4		3991.793	4	
3823.035	2		3870.824	8h	2H	3922.221	4	2	3993.532	100	4
3824.938	200	50	3871.231	100	4	3922.338	10	2	3994.562	10	
3826.103	60	6	3871.695	10		3923.486	1000	200	3995.982	200	10
3826.259	4	1	3872.381	6		3924.636	60	20	3996.504	100	6
3826.864	2H		3872.730	4		3925.930	1000	150	3997.954	6	
3827.552	10h		3873.537	200	40	3926.46	3	1	3999.488	4	
3827.92		3h	3876.102	150	6	3927.401	2		4000.103	4	
3828.719	125	10	3876.679	100	4	3929.554	1h		4000.550	4	
3829.336	50	5	3877.575	4		3929.854	6h		4002.957		60
3829.493	20	2	3878.771	4		3931.787	600	50	4005.089	6	1
3830.875	50	5	3879.023	2	50	3932.287	3		4005.646	200	20
3831.795	200	60	3879.305	4		3932.828		10h	4006.602	150	10
3832.272	2	5h	3880.833	60	4	3933.566	300	20	4007.533	100	6
3834.229	5		3882.034	125	6	3935.363	2		4008.266	125	
3835.062	150	20	3884.075	100	15	3935.722	2h		4009.928	1	100H
3835.983	20	1	3884.718	100	10	3936.168	4		4011.732	20	
3836.715	30		3885.823		2h	3936.787	6		4013.502	125	6
3836.968	3		3887.308	2		3937.919	250	15	4013.736	40	4
3838.069	150	15	3887.826	100	10	3939.126	10		4014.153	40	6
3838.725	80	5	3888.322	2		3941.672	200	8	4015.448	4	
3839.699	400	60	3889.43		1h	3942.078	200	8	4016.128	2	
3840.823	125	6	3890.216	125	15	3944.200	200	6	4016.740	20	
3840.989	100	6	3891.425	60	4	3944.795	6	1	4017.810	1	
3842.671	30	2	3892.230	500	60	3945.586	1000	60	4018.142	4	
3843.152	150	8	3892.773	40	4	3946.321	60	2	4019.551	60	4
3843.462		6h	3894.255	50	2	3949.417	60	4	4020.994	150	15
3844.660	2		3895.775	10h		3950.041	150	20	4022.168	800	100
3846.672	300	50	3895.984		2h	3950.230	200	25	4022.680	30	1
3846.801	50	4	3897.249	125	6	3950.410	150	20	4023.832	600	60
3847.491	2		3897.711	6		3951.212	125	10	4024.300	50	1
3848.944	40	2	3898.366	125	6	3952.290	20	2	4024.689	100	4
3849.449	4	2	3899.95		2h	3952.703	200	30	4025.28		2h
3850.441	400	80	3901.257	150	10	3953.849	10h		4025.465	2	
3852.132	125	20	3902.088	5H		3954.168	2		4025.857	1	
3852.565	10	1	3902.138		2h	3954.889	6h		4026.179	2	
3852.835	20		3902.824	15		3957.228	40	2	4026.492	10	1

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
4027.856	1		4087.562	4H		4145.737	1500	50	4199.892	3000	200
4028.434	40	1	4088.370	40		4146.770	600	60	4205.678	20	2
4030.120	6		4089.598	1		4148.376	200	10	4206.020	800	70
4031.003	200	2	4091.062	150	6	4149.886	2h		4207.626	150	20
4032.207	200	4	4093.688	2		4150.303	100	6	4212.062	1500	150
4032.509	50	1	4093.792	10		4150.620	10	2	4214.445	300	60
4033.724	1		4097.022	250	6	4152.922	2		4214.553	100	30
4036.468	40	1	4097.787	1000	100	4153.865	30	2	4217.263	200	30
4037.738	80	2	4100.365	150	4	4154.527	1		4220.675	160	20
4039.215	300	10	4101.226	40		4156.254	25	2h	4221.494	2h	
4040.474	50		4101.742	300	60	4157.167	20H		4223.347	1	
4041.259	6		4102.281	150	4	4157.734	50	2	4223.626	6Hw	
4041.980	20		4103.586	4h		4158.260	4		4225.095	120	10
4044.262	2		4104.049	2		4158.967	6		4226.668	20	6
4044.710	2		4104.515	2		4159.168	80	4	4227.831		4H
4045.770	150	10	4104.80		20h	4160.408	6H		4229.312	100	6
4046.883	20		4105.909	50		4161.655	250	30	4230.309	250	15
4046.964	10		4106.217	2		4163.350	4		4231.437		2H
4047.346	4		4106.573	2		4164.387	10		4232.321	100	4
4049.418	150	10	4107.837	200	10	4166.879	150	6	4236.675	60	4
4051.402	1000	300	4108.055	100	4	4167.514	2000	100	4239.660	6	
4052.194	200	30	4108.626	6		4168.758	6		4240.031	4	
4054.050	600	150	4109.640	60	2	4170.050	200	10	4241.058	400	30
4054.713	10	1	4112.741	2000	400	4170.592	4		4243.058	400	40
4055.446	2		4113.380	150	30	4170.908	1		4244.834	60	4
4056.766	6H		4114.128	60	2	4171.577	1		4246.342	100	6
4057.467	1		4114.808	4		4171.686	4		4246.736	125	30
4057.562	1		4116.853	10		4172.464	1		4246.936	1	
4058.100	2		4117.76	4		4172.994	15h		4248.150	30	2
4058.852	25		4118.500	200	4	4173.396	20		4250.615	3	
4059.427	4		4119.458	6		4173.991		4H	4255.397	2	
4060.393	1		4120.986	300	10	4174.912	1	50h	4255.716	10	
4062.854	60	6	4121.126	100	2	4175.299	10		4255.887	2	
4062.989	200	10	4122.786	5	1	4175.436	30	2	4256.608	3h	
4063.325	20		4123.061	300	20	4175.614	6h		4258.989	200	30
4064.105	200	15	4123.801	75	4	4177.939	1		4260.007	100	6
4064.456	600	30	4126.407	30		4182.455	200	15	4262.472	1	
4066.222	6		4127.439	200	10	4182.646	100	4	4263.403	30	2
4067.610	200	40	4127.869	200	20	4182.832	60	4	4265.618	40	4
4068.367	600	100	4128.664	2		4185.465	10		4265.990	4	
4070.400	2h		4131.215	20	2	4188.380	4		4269.053	2	
4071.398	150	10	4133.614	1		4189.463	150	2	4272.957	6	
4071.865	20		4133.804	2		4191.022	6		4274.639	1	
4072.996	125	4	4134.854	50	1	4191.496	2h		4277.272	30	2
4073.116	60	2	4135.466		2H	4192.582	1		4278.272	1	
4074.469	2h		4135.872	2		4193.382	2		4278.698	30	2
4075.978	3		4137.223	200	10	4193.586	2		4280.058	1	
4076.730	800	100	4137.710	10H		4193.613	2		4281.941	30	4h
4079.277	100	2	4137.948	4		4193.723	4		4282.219	80	6
4080.599	1500	800	4139.192	2		4194.673	1		4282.972	6	
4082.789	100	2	4139.522	1		4195.698	6h		4283.113	1	
4083.868	4		4140.017	6		4196.138	6h		4284.330	400	60
4084.676	4H		4140.276	4		4196.863	200	30	4287.048	200	20
4085.353	100	2	4141.856	2	1h	4197.572	400	50	4288.622	1h	
4085.432	300	10	4144.160	2000	150	4198.864	400	40	4290.551	30	2h

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
4291.269	1h		4385.393	400	50	4491.674	100	1	4592.513	200	10
4291.642	1h		4385.650	400	50	4492.920	1		4592.995	10	
4292.274	6		4386.272	80	10	4496.780	1		4593.195	10	
4293.284	150	20	4388.106	1h		4498.138	200	16	4594.641	1	
4294.793	200	30	4388.998	30	2h	4508.043	40	1	4595.404	1	
4295.932	150	40	4390.440	500	100	4508.553	60	2	4596.703	150	10
4296.694	10	1	4391.031	100	6	4510.082	160	4	4597.331	1	
4297.714	1000	400	4394.970	30	2h	4511.183	140	2	4597.697	1	
4301.154	10	1	4396.700	2		4514.83	2		4599.082	500	60
4302.017	2		4397.803	150	10h	4516.272	50	1	4600.54	6h	
4303.304	1		4398.733	1h		4516.877	200	20	4601.757	150	
4305.885		10h	4399.597	60	2h	4517.794	160	8	4602.820	30	
4307.604	400	60	4402.286	2		4520.931	160	10	4605.671	150	2
4308.404	1		4404.815	40	4h	4525.188	4h		4606.824	30h	
4309.215	50	2	4410.028	500	200	4525.931	2h		4608.673	2	
4312.494	16	2h	4412.324	1	1	4526.409	2h		4608.99	1	
4312.902	1		4413.300	20	8	4529.044	4		4610.492	10	
4314.308	60	4	4414.995	4		4530.860	200	10	4612.328	60	
4315.558	20		4420.852	100	20	4531.78	4h		4615.425	2	
4316.643	50	4	4421.456	150	50	4532.443	10		4616.093	2	
4318.441	150	20	4422.978	4	2	4533.301	1		4617.662	30	
4319.132	10	1	4424.796	50	10	4534.480	2		4618.024	4h	
4319.871	150	20	4426.014	4		4535.584	50		4618.799	6	1
4320.585	8	1	4428.441	250	150	4537.444	1		4620.009	6	
4320.826	8	1	4430.309	4	1	4538.658	8h		4624.322	8	
4321.307	20	1	4433.641	1		4542.430	10		4624.464	4	
4322.971	20	4H	4438.343	2	2h	4543.690	150	2	4626.035	20	
4323.469	2h		4439.413	10	2	4545.713	8		4628.337	30	
4325.059	150	20	4439.745	250	50	4546.930	125		4630.442	10	
4326.822	150	15	4440.069	10	2	4547.278	200	20	4630.688	2	
4327.425	100	6	4444.494	150	30	4547.850	150	20	4631.74	1	
4328.563	16	2	4449.322	400	150	4549.423	80		4633.173	2	
4331.168	100	6	4452.520	1		4549.940	120	6	4633.470	2	
4332.505	40	4h	4460.031	800	250	4552.118	200	2	4635.682	300	20
4332.649	10	1	4461.472	8	1	4554.514	1500	300	4638.419	20h	
4335.125	1		4465.483	10	4	4556.064	10		4639.318	20	
4336.431	80	4	4466.352	30	4	4557.811	6		4640.770	6h	
4337.268	200	6	4467.257	40	10	4559.982	200	4	4640.983	30	
4338.675	20	2h	4470.502		50	4562.601	50		4642.393	15	
4340.351	40	4h	4471.018	6		4564.693	100	2	4642.601	40	
4341.050	30	2h	4472.257	4		4566.681	1		4645.09	200	40
4342.073	400	50	4473.324	30		4567.885	2		4646.810	6	
4346.484	100	10	4473.909	150	10	4570.241	10		4647.594	600	40
4349.704	200	30	4475.640	2		4575.738	4		4648.158	60	
4354.130	250	60	4475.880	2		4576.303	2		4650.211	4	
4354.804	100	6	4476.475	4h		4577.416	4		4652.498	4	
4361.204	1000	150	4477.97	4		4580.068	150	4	4653.322	2h	
4362.707	10		4479.393	60	1	4584.440	1000	100	4653.759	70	1
4364.108	10	1	4480.434	150	10	4587.099	60	2h	4654.311	400	30
4368.761	4		4482.031	60	1	4587.800	2h		4654.780	50	
4370.418	40	1	4483.824	1		4589.574	15		4656.415	60	
4371.209	60	4	4484.674	1		4590.727	2h		4657.402	15h	
4372.200	2000	200	4486.801	1		4591.097	200		4660.640	4	
4381.276	30	2h	4488.377	150	4	4591.546	100		4662.254	6	
4383.368	60	10	4490.220	140	2	4592.005	6		4662.494	20	

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
4665.000	10		4761.533	6		4852.898	2		4940.131	1	
4669.139	100	1	4764.406	150		4853.503	50		4941.575	20	
4669.973	250	4	4766.647	4		4854.559	150		4942.37	4h	
4671.368	6		4767.153	60		4857.990	2		4944.006	60	
4674.638	300	30	4769.306	300	10	4859.245	2		4944.404	20	
4681.408	40	1	4773.155	125	1	4860.157	8		4951.26	2	
4681.780	400	50	4774.004	125	4	4860.444	15		4955.272	200	6
4682.096	20		4781.112	15		4861.865	150	60	4959.872	150	2
4684.013	300	30	4781.770	50		4863.105	60	10	4962.872	1	
4685.052	2		4783.300	20		4865.090	75	40	4964.079	6	
4685.778	50	2	4784.266	150		4869.163	1000	200	4964.885	15	
4690.114	400	50	4785.079	1		4869.782	100		4966.109	10	
4692.912	2h		4787.357	10		4871.368	1h		4967.368	10	
4695.253	10		4790.809	4h		4871.588	4		4967.618	30	
4698.700	1		4794.386	150		4874.329	150	1	4968.006	50	1
4700.261	2		4795.575	150		4875.020	160	1	4968.900	300	10
4705.16	1		4798.450	150		4875.998	6h		4970.181	6	
4709.482	1000	200	4801.180	60		4877.414	50		4970.798	10	
4710.968	20		4802.91	20		4877.885	30		4971.414	10	
4711.988	80		4804.887	200	4	4882.654	50		4974.106	150	6
4712.502	16h		4806.212	80	2	4885.016	40		4975.371	100	
4713.370	10		4807.633	4		4886.347	6h		4976.200	250	6
4713.567	4		4809.714	20		4887.538	1		4977.208	10h	
4714.17		1h	4810.693	4		4888.605	30		4977.982	50	
4714.834	1		4812.225	6		4889.820	20h		4980.359	300	10
4715.615	6		4812.849	6		4892.824	10h		4983.103	6h	
4716.049	100	1	4813.231	20	5	4894.208	4		4983.443	150	2
4718.061	20		4814.099	2		4895.340	200	10	4984.695	30	
4718.840	6		4814.741	25	6H	4895.609	400	20	4987.262	160	4
4720.920	120	2	4815.531	200	125	4899.255	200	4	4991.196	2h	
4721.848	1		4817.353	60	20	4901.071	100	1	4992.741	200	10
4723.226	10		4820.251	2		4901.855	80		4994.898	10	
4724.799	40		4822.584	80		4903.066	600	100	4996.24	1	
4727.584	4		4824.356	2		4904.593	60h		4998.049	10h	
4728.586	2h		4825.751	4		4905.030	150	2	4999.00	1h	
4731.323	300	20	4826.207	30h		4907.895	200	6	4999.538	6h	
4733.319	150		4826.567	30h		4910.236	125		5002.653	4h	
4733.520	300	20	4827.648	4h		4911.598	100		5003.523	125	
4738.410	100	2	4827.867	4h		4913.278	60		5005.243	100	
4740.332	10		4828.683	40		4914.195	80		5010.600	125	
4741.273	20H		4831.633	2		4917.341	20		5011.234	250	10
4742.486	2H		4832.998	200	6	4918.369	6		5014.320	1	
4743.028	125	4	4836.412	1		4919.004	125		5014.957	200	10
4743.670	2		4838.161	40		4919.646	4		5015.997	2	
4743.984	2		4839.014	150		4921.081	500	40	5016.816	8	
4744.654	4		4839.760	125		4923.725	2		5018.961	150	2
4745.859	1		4841.756	10		4924.518	2		5020.315	80	1
4749.803	2		4843.767	10		4930.934	4		5026.197	300	5
4750.040		3	4844.560	200	20	4931.73	1		5028.162	200	5
4751.015	30		4845.899	6		4932.37	1		5031.895	4	
4751.454	4h		4846.111	4		4934.613	10		5032.34	1	
4752.140	30		4847.871	10		4935.640	150		5032.900	2	
4753.844	6		4848.166	15		4936.244	50		5036.986	6	
4756.244	250	10	4851.935	6		4937.219	125		5039.037	10	
4757.844	500	60	4852.60	1		4938.444	200	10	5039.627	150	1

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
5040.357	125	3	5153.214	125	4	5272.002	10		5395.385	40	1
5040.738	160	5	5154.604	60		5273.46	1		5397.976	2	
5041.350	20		5155.140	400	25	5274.042	10		5401.047	500	10H
5041.978	20		5160.008	150	8	5275.087	150	1	5401.402	400	5H
5045.432	100		5166.234	2h		5275.756	60		5403.329	2	
5047.308	200	5	5168.062	50	1	5278.375	60	1	5405.249	4	
5052.955	100	2	5168.636	20		5280.074	20h		5405.384	4	
5057.340	1000	25	5170.078	20h	1	5280.812	150	2	5410.377	20	
5057.68	10		5171.026	1000	100	5284.089	300	10	5410.810	2	
5062.658	125	2	5173.937	40H		5284.418	50	1	5412.839	10	
5063.196	15		5177.993	50		5291.169	150	5	5413.75	1	
5066.668	10	1	5178.643	10h		5291.886	2		5415.38	1	
5067.62	1h		5181.348	2h		5293.226	2		5416.494	15h	
5067.790	60	1	5183.608	4h		5296.22	3		5417.344	20	1
5071.013	60	1	5184.753	30		5304.852	200	6	5418.864	250	6
5072.993	250	7	5186.52	1		5305.850	50	2	5419.13	5H	
5074.76	1h		5188.410	6		5306.453	50	3	5420.15	1	
5075.641	4h		5189.699	20	1	5307.284	60	1h	5421.120	4	
5076.087	100	2	5193.026	4		5309.259	1000	6	5424.722	4	
5076.327	300	6	5195.017	400	15	5315.339	200	4	5427.610	400	5H
5079.463	125	1	5195.41	1		5316.589	4		5429.96	1h	
5080.744	6h		5197.058	50	1	5317.92	1		5430.928	4h	
5081.466	2h		5199.873	150	10h	5318.749	6		5433.64	2h	
5082.91	1		5202.127	100	8	5320.830	6		5436.65	1	
5083.992	2h		5202.897	4h		5325.37	1		5439.218	150	1h
5084.58	1h		5205.330	2h		5327.065	10H		5439.416	100	1h
5086.776	150	1h	5209.502	100	2	5328.023	50	1	5440.206	60	1
5090.086	100	1	5213.440	300	2H	5328.822	2		5444.621	4	
5093.850	600	15	5214.079	100	1H	5332.932	150	5	5448.471	6	
5094.629	4	1	5219.072	4		5334.716	200	2H	5449.51	2	
5096.220	20		5223.550	300	6	5335.924	250	10	5450.04	2	
5100.850	10h		5224.135	2h		5340.175	4		5452.728	100	1h
5101.395	200	5	5225.086	50		5341.712	4		5453.388	6	
5101.724	125	2	5226.362	2h		5342.230	4		5453.974	4	
5106.570	100	5	5227.278	40	1	5343.308	2		5454.26	4	
5107.071	200	10	5235.578	60		5346.791	50		5454.809	250	6h
5111.249	2h		5236.951	10		5347.20	1		5456.124	200	10
5113.06	50H	1H	5242.386	200	2H	5348.132	80	1	5458.802	6	
5114.590	40	1	5242.951	150	1H	5348.58	1		5461.902	20	
5114.996	60	1	5244.234	2h		5350.420	100		5463.161	15	
5119.866	30		5244.971	10h		5353.693	6		5464.913	20	
5121.430	15		5245.453	50	2	5354.952	20		5468.228	10	
5122.975	30h		5246.840	2h		5359.644	100		5470.266	4	
5123.761	125	2	5250.458	10		5361.792	600	6H	5471.526	40h	
5126.775	6		5251.664	300	1H	5362.094	50	1	5472.852	80	1
5127.265	150	4	5255.445	1		5365.604	125		5473.674	20h	
5129.279	30		5257.081	200	2H	5369.226	10h		5475.187	150	1h
5133.895	200	5	5263.960	100	1h	5373.281	20		5476.360	60	1
5134.111	150	2	5265.922	30		5373.409	25		5479.415	250	6h
5136.558	1000	50	5266.232	40		5377.068	60	1	5480.305	200	6h
5142.325	40		5266.469	100	3	5377.840	300	5h	5481.130	4	
5142.772	400	10	5266.815	100	3	5384.12	3h		5482.180	10	
5147.246	400	15	5269.139	2		5385.898	200	6	5483.251	10h	
5149.753	10	1	5271.174	4		5388.629	50	6	5484.325	200	10
5151.070	300	10	5271.45	1		5391.59	2h		5484.646	100	3

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
5485.11	2h		5645.74	1		5762.345	16h		5926.862	150	4
5485.702	20h		5647.577	60		5763.659	30		5928.362	6	
5490.578	30		5647.888	80h		5766.119	4		5929.292	4	
5490.824	2		5648.695	1		5766.589	2		5929.630	2	
5494.36	100		5649.569	125	1	5766.905	6		5932.384	100	
5496.696	160	4	5650.818	10		5767.923	100	2	5936.644	150	2
5498.999	4		5652.80	1		5771.215	30		5938.580	40	
5499.641	30		5653.314	80	1	5774.384	100		5943.728	20	
5501.024	150	1h	5656.640	10		5774.847	4h		5944.386	50	
5501.660	4h		5656.978	60		5776.866	6h		5951.154	125	
5502.20	1		5658.442	10		5779.961	6		5953.382	10	
5506.940	50		5663.071	6		5782.365	60		5969.348	60	
5510.723	500	20	5665.206	100		5782.572	80	3	5970.544	30	
5512.378	80	3	5670.512	6		5783.751	20h		5973.370	400	1H
5517.846	60	2	5671.93	2		5784.091	20h		5973.672	100	2
5519.13	2h		5674.844	10h		5784.78	1		5974.162	150	2
5521.780	60	1	5676.556	30		5790.588	50		5978.022	1h	
5522.626	6h		5679.623	100		5792.226	50		5980.643	10	
5524.148	4		5681.524	4		5798.845	6		5982.243	8	
5524.755	2h		5682.26	1		5800.011	10h		5984.966	2h	
5526.116	6		5688.830	50		5802.016	10		5986.63	4h	
5526.346	6		5692.114	6		5804.382	150	4	5988.676	200	5
5531.001	60	1	5693.032	100	1h	5807.960	60h		5989.594	2h	
5540.659	150	3	5694.462	50	1	5810.87	2		5991.178	6	
5542.35	4		5696.35	80		5813.014	2		5991.194	3	
5549.749	30		5699.049	600	30	5814.988	400	6	5991.485	2	
5553.78	1		5699.58	100	2	5820.01	1		5991.497	4	
5556.524	100	2	5702.368	150	3	5825.29	100		5992.580	20	
5559.744	400	10	5705.15	2		5825.846	30		5993.658	150	6
5569.036	150	3	5711.27	1h		5827.316	10		6002.889	4	
5570.71	15	1	5712.86	150	1	5828.075	100	4	6003.872	30	
5572.30	2		5714.233	40	1	5828.408	50	1	6004.454	6h	
5578.412	500	2	5715.89	4h		5830.844	10		6006.972	2	
5578.688	10	1	5718.96	2		5833.197	100	1h	6009.108	6	
5579.435	60		5723.058	40		5833.407	60	1h	6012.776	6	
5583.054	4h		5724.818	125	4	5864.624	30		6021.840	30h	
5587.436	4		5725.740	100	3	5874.378	6		6022.302	100	2
5595.208	20		5729.963	50h	1h	5875.797	4		6026.344	4	
5600.530	50		5730.589	40h	1h	5886.611	2h		6027.497	40h	
5603.144	125	3	5731.295	1		5887.161	40		6029.103	60	
5603.552	100	2	5732.90	4h		5887.692	10		6033.341	20	
5606.748	150	1	5734.445	10		5888.383	10		6037.735	4h	
5607.744	4h	5	5735.54	1H		5888.74	15H		6038.734	4	
5609.147	100		5736.980	4		5891.95	4		6046.376	100	1
5611.398	6		5737.43	1		5893.612	2	10	6054.071	20	
5619.374	4		5740.555	40		5894.721	8		6057.453	4h	
5625.07	2h		5745.65	100		5896.488	1		6065.189	20	
5627.506	60h		5746.002	150	2	5896.894	15		6073.90	10	
5629.798	60	1	5747.481	150		5901.18	20h		6077.79	1h	
5631.584	30h		5752.022	125	1	5902.284	2		6078.212	4h	
5633.560	20		5753.621	20		5904.426	80		6078.831	2	
5636.233	1000	100	5756.188	16h		5914.226	60	1	6080.08	200	
5636.71	2		5756.832	100	1	5919.340	200	10	6081.39	1	
5638.716	6h		5758.722	60		5921.450	500	10	6082.298	15h	
5641.671	100	1	5760.23	1		5924.362	6h		6083.522	60	

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
6085.121	50	1h	6304.07	60	4h	6540.24	70	4h	6805.05	2	
6089.426	10		6304.49	40		6544.23	15		6805.53	8	
6090.522	300		6306.79	10		6556.24	2		6807.00	1	
6096.891	4h		6307.60	2		6557.83	2		6812.90	8	
6101.560	15		6309.66	60		6559.46	6		6813.52	40	
6103.69	10H	3	6310.37	4h	1h	6560.45	60	4h	6821.73	3	
6108.97	100		6311.10	50		6561.49	2		6823.88	100	
6114.976	6		6311.39	4		6569.09	15		6824.17	150	
6116.770	300		6316.73	60		6577.96	2		6829.27	1	
6119.844	60		6324.24	50		6593.75	30		6831.44	20	
6121.032	6	3	6330.62	150	20	6596.58	10	4h	6831.54	30	
6122.376	50		6331.52	3		6613.11	10		6832.71	1	
6137.77	1		6336.10	30		6618.22	50		6834.11	1	
6141.527	60		6343.07	20		6620.40	2		6836.06	3	
6150.073	10		6351.90	20		6633.40	3		6837.04	3	
6170.237	6	2	6357.75	15	1	6635.27	10	4h	6837.96	10	
6170.605	200		6357.95	150		6640.88	6		6841.55	1	
6173.127	10		6363.41	100		6649.54	7		6843.13	2	
6174.210	50		6371.29	2		6651.47	7		6843.83	1	
6176.774	100		6376.45	100		6658.83	2		6850.84	5	
6177.736	10	2	6382.98	60	3	6662.68	200	4h	6852.93	1	
6179.973	4		6384.66	50		6663.16			6858.76	1h	
6185.835	10		6388.06	15		6664.10			6867.16	2	
6189.488	10		6388.79	1		6667.72			6872.92	20	
6192.552	300		6390.21	80		6669.72			6875.15	1	
6195.33	30	5	6395.89	2	1	6676.62	1	4h	6879.28	1h	
6195.97	20		6401.40	5		6688.22	2		6883.51	3	
6197.15	10		6404.86	2		6690.01	400		6885.66	9h	
6199.42	400		6406.07	10		6702.08	20		6891.70	1	
6210.31	30h		6413.33	2		6706.78	2		6891.98	2	
6210.75	50	1	6417.56	100	1h	6707.56	30	4h	6902.25	6	
6213.63	4		6429.55	10		6717.57	2		6908.25	1	
6217.35	2H		6432.10	6		6718.31	80		6909.75	3	
6217.52	4		6440.33	10		6718.91	2		6911.46	200	
6219.58	10		6444.84	200		6721.81	7		6912.47	1	
6225.22	300	1	6445.85	4	1	6724.87	1	4h	6913.83	3	
6225.67	10		6451.88	4		6730.46	80		6918.50	20	
6231.81	20		6456.91	8		6731.79	20		6920.13	2	
6232.75	4		6457.43	10		6733.95	3		6921.97	4	
6233.68	6h		6461.19	4		6738.12	2		6923.21	800	
6235.63	100	1	6464.27	6	1	6742.92	10	4h	6926.67	2	
6235.97	10h		6468.64	9		6749.81	1		6928.71	2	
6241.62	10		6472.51	8		6750.39	2		6929.90	1	
6252.067	150		6477.90	7h		6751.73	10		6934.20	1	
6255.293	6		6482.22	4		6756.54	100		6934.83	20	
6258.00	6	4	6484.49	12	1	6760.87	2	4h	6937.07	1	
6270.07	4		6492.36	3		6766.77	50		6938.13	3	
6274.503	20		6496.43	100		6766.98	150		6952.10	1h	
6275.12	4		6499.78	2		6770.15	2		6958.34	3	
6284.49	100		6506.26	2		6775.01	100		6958.85	3	
6285.68	6	4	6509.64	2	1	6778.30	1h	4h	6959.78	1	
6289.34	4		6519.06	30		6779.15	2		6960.76	20	
6290.100	50		6520.91	4		6787.20	60		6963.06	1	
6295.220	300		6528.73	90		6789.68	2		6968.43	2	
6303.242	30		6531.60	2		6792.94	1		6971.12	1	

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
6980.62	1		7183.01	30		7393.93	800		7621.52	500	
6981.98	300		7192.39	3h		7405.70	1		7633.11	3h	
6995.49	3		7194.50	20		7407.51	20		7647.41	5	
6997.56	1h		7205.87	2		7410.27	40		7658.43	50	
6998.27	4		7212.57	10		7410.62	5		7660.35	5	
7001.63	40		7219.26	150		7419.59	10		7665.14	10	
7001.84	4		7225.32	5		7425.44	1		7669.61	1h	
7012.87	1		7226.33	3h		7427.66	1h		7677.45	20h	
7016.13	3		7229.81	4		7429.55	2		7683.18	1	
7017.46	4		7233.96	4		7430.57	2		7687.50	20h	
7027.95	400		7236.61	3		7430.76	50		7688.62	1	
7032.32	1		7238.90	400		7438.32	20		7690.54	3	
7033.12	3		7240.22	20		7445.44	20		7691.61	2h	
7034.47	10h		7240.41	3		7448.37	2h		7694.52	3	
7035.00	1		7247.12	1		7449.66	10		7697.42	4d	
7035.87	2		7247.54	1h		7450.62	30h 1		7697.67	1	
7039.85	2		7249.10	10		7450.80	4		7701.42	9	
7042.49	1		7255.16	2		7453.62	40		7719.26	10	
7052.90	2		7255.47	1		7454.15	2		7720.45	10	
7054.80	3h		7260.65	1		7458.43	9		7722.89	500	
7057.12	9		7264.97	2		7463.70	30		7728.99	3	
7058.42	10		7266.95	100		7465.77	5		7729.87	20	
7060.36	60		7267.76	10		7467.78	1		7733.99	2	
7061.12	10h		7268.02	1		7468.91	700	5	7736.19	1	
7061.25	100		7272.24	4h		7475.40	300		7737.17	2h	
7061.80	1		7284.65	1		7485.75	800		7739.79	4	
7070.15	8		7289.76	3h		7486.07	30		7744.45	1	
7073.70	1		7290.90	2h		7495.18	4		7747.19	1	
7076.16	1		7297.10	20		7499.74	800		7750.54	5	
7080.32	2		7306.36	2		7503.09	6		7759.63	6	
7083.69	8		7312.63	30		7511.72	2		7770.86	7	
7086.04	200		7315.66	20		7514.73	1		7774.98	2	
7087.32	200		7318.81	4		7516.05	2		7781.34	6	
7103.40	4		7319.88	1h		7519.59	30		7788.90	3h	
7104.15	2		7322.06	7		7526.49	7		7789.58	2	
7110.57	20h		7323.57	150		7529.58	100		7791.81	300	
7120.43	1h		7326.21	3		7532.07	150		7797.90	80	
7120.74	2		7329.82	10		7540.85	7		7800.16	3	
7126.80	70		7334.43	1		7541.67	7		7802.32	1h	
7130.64	2		7338.89	10		7544.19	6		7806.52	2	
7135.17	15		7339.73	1		7545.08	1		7806.78	100	
7135.64	20		7341.44	9		7549.87	2		7809.19	5	
7140.81	6		7341.82	5		7554.28	20		7813.43	40	
7141.71	70		7342.39	4		7559.62	700		7813.96	5	
7146.41	3		7343.49	1		7563.68	2		7815.38	5h	
7154.18	40		7348.72	40		7569.34	5		7829.81	70	
7160.06	1		7350.67	1		7575.08	10		7830.51	10	
7165.83	2h		7351.92	8		7581.36	4		7833.37	100	
7167.76	15		7356.27	2h		7596.87	2h		7834.02	1	
7168.46	5		7374.31	2h		7598.23	3		7834.78	40	
7171.75	2		7377.31	2h		7600.39	1		7838.42	3	
7175.18	1		7377.77	100		7609.01	4		7840.39	1	
7175.78	3		7381.09	40		7611.50	4		7841.92	100	
7178.94	2h		7382.81	2		7612.97	100		7844.83	1	
7182.20	15		7391.33	2		7616.74	5		7847.81	300	

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
7853.76	20		8133.44	1h		8503.42	2		9216.46	2	
7862.70	1		8144.33	1		8506.01	1		9224.59	1	
7867.58	2h		8148.48	9		8511.81	3		9232.01	7	
7871.92	10		8157.69	15		8522.21	1h		9244.36	1	
7875.27	3		8168.85	20		8523.23	5		9250.01	2	
7876.78	10		8173.91	15		8556.05	9		9253.42	2	
7881.47	200		8181.99	30h		8570.84	1		9257.46	2h	
7890.40	100		8184.96	1h		8585.67	4		9260.93	2h	
7893.22	7		8185.82	2		8593.20	2		9262.75	3h	
7894.69	1		8188.03	1h		8609.02	3		9266.02	4h	
7898.48	3		8194.54	8h		8616.83	2		9271.16	3	
7900.20	30		8216.25	5		8637.05	10		9273.15	200	
7904.10	6		8220.48	50		8649.99	2		9280.75	5h	
7905.17	9		8231.96	2		8656.55	1		9285.60	1h	
7906.10	20		8235.71	2h		8658.95	10		9287.92	1	
7908.73	10		8237.46	4		8693.15	2		9288.60	1	
7909.84	1		8239.21	15h		8710.84	200		9297.53	10	
7917.53	7		8241.24	1		8724.97	100		9300.70	2	
7919.75	5		8246.80	4		8741.88	5		9307.23	1	
7922.97	60		8251.32	3		8754.37	1		9319.87	15	
7924.45	100		8260.22	8		8756.12	1		9322.77	50	
7928.41	2		8264.95	400		8757.45	2		9325.77	3	
7930.36	4		8269.02	3h		8777.36	60		9341.10	1	
7941.08	3		8281.00	2		8839.92	1		9344.62	4h	
7947.97	10		8281.98	30		8856.89	20		9355.23	1	
7948.15	200		8291.89	1h		8867.64	5		9386.81	1	
7950.45	1h		8296.45	2		8868.06	20		9387.75	2	
7953.05	1		8297.23	2		8873.76	2		9392.78	4	
7963.83	6		8304.90	2		8876.55	1		9396.09	15	
7967.88	200		8309.04	2		8893.29	1		9407.76	20	
7974.74	2h		8320.13	2h		8896.66	2		9431.15	1	
7993.75	5		8330.16	1		8944.57	1		9437.11	1	
7994.63	6		8348.99	250		8948.51	3		9445.03	20	
7999.28	2		8350.23	7		8953.57	5		9452.67	1	
7999.79	20		8352.93	200		8957.14	5h		9463.41	4	
8009.64	4		8354.92	1		9023.54	3		9485.79	1	
8017.64	20		8376.90	4		9037.27	1		9492.49	5	
8028.28	1		8377.62	1		9039.92	3		9518.09	6	
8036.68	60		8384.12	3		9053.45	2		9535.45	3	
8043.36	2		8388.96	10		9059.26	2		9538.48	1	
8049.79	3		8395.68	1		9066.50	2		9539.87	50	
8050.29	2		8400.60	15		9079.09	1		9557.05	1	
8055.05	1h		8420.40	2		9081.78	2h		9561.68	50	
8058.45	3		8434.45	1h		9084.95	50		9565.95	1	
8061.13	3h		8435.77	80		9107.72	8		9569.01	2	
8074.43	10		8440.42	4		9126.45	10		9585.26	60	
8082.06	2		8448.69	30		9134.63	4		9587.00	3	
8083.23	2h		8454.92	2		9139.04	15		9588.83	1	
8089.47	7		8456.70	2		9155.72	15		9593.28	1	
8090.23	20		8473.66	200		9156.72	1		9603.68	1	
8091.05	2		8480.60	9		9165.22	90		9613.40	1h	
8099.28	1		8483.56	200		9169.71	1		9622.37	3	
8105.47	4		8490.45	6		9175.86	5		9624.25	2H	
8112.47	150		8494.06	7		9186.16	2		9627.62	2	
8114.05	1		8497.94	3		9189.20	150		9632.53	1	

Table 1. Arc and spark spectra of ruthenium - Continued

Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity		Wave-length, A	Intensity	
	Arc	Spark		Arc	Spark		Arc	Spark		Arc	Spark
9642.75	1		9760.5	2h		9916.63	3		10580.54	2h	
9646.43	15h		9765.83	1		9920.03	1		10597.77	100c	
9664.60	3		9768.26	1h		9921.14	1		10609.24	2h	
9671.71	1h		9778.20	1h		9925.07	3		10630.05	4	
9677.96	1h		9780.2	1		9946.83	5		10649.83	6	
9688.45	2h		9791.77	60		10024.99	15h		10786.22	1	
9694.93	30		9801.15	1h		10054.15	20		10815.28	3h	
9706.51	1		9802.65	1		10067.67	1h		10838.05	2	
9714.44	5		9808.28	1		10082.93	30		10850.32	1	
9715.83	1		9820.88	2h		10140.42	1h		10858.97	1	
9717.08	1		9828.92	4h		10215.71	1h		10937.16	2h	
9722.59	3h		9842.26	1h		10221.18	3h		10953.4	1h	
9726.44	3h		9843.92	1		10228.91	8		11184.28	4	
9729.37	2		9849.75	2		10286.65	3		11199.67	8	
9732.17	1h		9867.36	3		10288.54	2		11298.66	3	
9735.23	5		9879.76	3		10289.39	2		11325.88	6	
9742.40	3		9887.87	150		10303.56	8		11483.91	3	
9747.44	4		9890.04	1		10371.28	6				
9751.24	2		9906.39	2h		10402.07	1h				
9759.05	1		9909.98	2h		10512.58	40				

WASHINGTON, January 27, 1955.